MO-STEM Professional Development Needs Assessment

Survey Results for Missouri K–12 STEM Teachers

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Introduction

There has been widespread call from the National Research Council and National Science Foundation to improve K–12 instruction in Science, Technology, Engineering, and Mathematics (STEM) (NRC, 2011; NRC, 2013). There is the ongoing need for high-quality STEM Professional Development (PD) for K–12 teachers to improve STEM teaching practices, but there is limited information to guide the design and dissemination of this instructional support.

The Experimental Program to Stimulate Competitive Research (EPSCoR) group in Missouri contracted a team of researchers at the Assessment Resource Center (ARC) at the University of Missouri to conduct a statewide STEM PD needs assessment. This report provides the findings from this MO-STEM PD Needs Assessment.

Purpose

The purpose of this project was to determine the current PD needs of educators teaching STEM topics throughout Missouri's K-12 schools. This report intends to help align the structure and content for PD with the teachers' reported needs and levels of interest. This report and the associated dataset can be used to develop strategies for providing PD that meets the needs of teachers in a variety of environments.

Brief Review of Literature

One key way to improve STEM instruction is through providing PD that meets the needs of teachers. A previous study explored the PD experiences and needs of secondary science and math teachers in Missouri (N = 241) (Chval, Abell, Pareja, Musikal, & Ritzka, 2007). This study included PD content topics specific to science (e.g., the solar system and the universe) or mathematics (e.g., algebra), and reported different perceived needs based on subject, grade level, or county size (i.e., urban, suburban, & rural) (Chval, et. al., 2007). Chval and colleagues found that the level of participation in science and mathematics PD is minimal, that teachers preferred PD related to subject area and grade level, and teachers expected the content from PD to be useful in their classrooms. With this work in mind, the MO-STEM PD Needs Assessment focused more on teachers' attitudes regarding modes of PD delivery, and importance of, and interest in, STEM PD topic areas relevant to their classroom.

Methods

MO-STEM PD Needs Assessment Survey Development

The Assessment Resource Center and EPSCoR team members developed the framework for the MO-STEM PD Needs Assessment that included the following emphasis areas:

(1) Teacher Demographic Information:
    Three items regarding grade level, subject, years of teaching experience

(2) Participation in Professional Development:
    Two items regarding hours of PD in past 12 months, and hours of PD related to STEM

(3) Professional Development Preferences:
    Four question clusters regarding general interest in PD (7 items), value/beliefs toward PD (8 items), preferred delivery of PD (9 items), and preferred format of PD delivery (10 items)

(4) Professional Development Topic Areas:
    Several question clusters regarding teachers' perceived importance of, and interest in, STEM PD topics and non-discipline-specific content areas (30 items)

(5) Level of Internet Access:
    One question cluster regarding types of online access at their school building (5 items)

These survey items were designed with alignment to Chval and colleagues where possible and were vetted by the EPSCoR team before the survey was administered to a stratified random sample of the population of STEM teachers in Missouri. The needs assessment survey was created as an online form (via Qualtrics) and also as a scannable paper survey.

Population of STEM Teachers in Missouri

According to data collected from the 2015–2016 academic year by the Missouri Department of Elementary and Secondary Education (DESE), there were 19,678 elementary teachers, 4,287 secondary math teachers, 4,155 secondary science teachers, and 336 technology/engineering teachers. These teachers represent 516 public school districts throughout the state of Missouri. For the purposes of this needs assessment, teachers from charter school districts or other special Local Educational Agencies (LEAs) were not included in the population.

The Process for Sampling STEM Teachers

Developing a strategic plan for sampling the STEM teacher population can increase both the validity of survey findings and allow opportunities to determine the unique professional development needs of teachers in a variety of contexts.

Equitable access to PD is likely to be related to the size of a district in which a teacher is employed. The size of the district would likely be a strong predictor of logistical or institutional barriers that might influence a teacher's access to PD in general. For example, a small district may have less funding for science materials and supplies or may be in a rural area, which affects the logistics of attending PD activities. Collaboration may be impossible in small districts with few math or science teachers. Large districts have different environments with different obstacles.

Therefore, the size of the district in which a STEM teacher is located was used to develop the key sub-population categories for purposeful sampling. Fortunately, the size of a school district is a salient and easily determined criterion.

Four criteria were used to determine the size of the teacher's district: (1) number of elementary teachers per district, (2) number of science teachers per district, (3) number of mathematics teachers per district, and (4) total student enrollment in the district. Districts were categorized as small, medium, or large and assigned a value of 1, 2, or 3, respectively, for each of the four criteria of district size. See Table 1 for further detail.

Table 1. Criteria for Scoring the Subcomponents of District Size

Criteria	Small District (1)	Medium District (2)	Large District (3)
Number of Elementary Teachers	1–49	50–200	> 200
Number of Science Teachers	1–9	10–40	> 41
Number of Math Teachers	1–9	10–40	> 41
Total Number of Students	< 3000	3000–10,000	> 10,000

The range of values for each criteria was established by creating a roughly even distribution of all Missouri teachers into three groups.

The sum of scores across the four criteria was used to identify three distinct clusters of districts and determine a district's overall subsample category of small, medium, or large using aggregate size scores of 1–4, 5–8, and 9–12, respectively. For example, a district with fewer than 50 elementary teachers, fewer than 10 math or science teachers and fewer than 3000 students would be categorized as a small district (Aggregate score = 4). In Missouri, 368 districts fall into this category, representing 71% of Missouri districts in the sample. Table 2 shows the number of districts in each size category. If a district was missing information, it received a score of 0 for that category which accounts for the aggregate score range of 1–4 for small districts.

Table 2. Number of Districts in Each Category

District Size (Aggregate Score)	Number of Districts (Percentage)
Small (1–4)	368 (71.3%)
Medium (5–8)	124 (24.0%)
Large (9–12)	24 (4.7%)
Total	516 (100.0%)

Note: For District Size, the sum score range for each size category is indicated ( ).

Table 3 is a matrix showing the number of elementary, secondary mathematics, secondary science, and technology/engineering teachers in small, medium, and large districts. Teachers assigned to a district within each category were part of the pool of educators from which a representative sample was selected for participation in the MO-STEM PD needs assessment. In order to recruit an appropriate number of teachers to provide a representative sample, the target number of teachers was calculated based on the approximate population size and assuming a 40% response rate, 4% margin of error, and 95% confidence level. The number of teachers who were invited to participate is indicated in parentheses in Table 3. Because the number of technology and engineering teachers was small, *all* of the technology and engineering teachers in Missouri were surveyed.

Table 3. Sampling Matrix with Population and Number of Teachers Invited to Participate

District Size	Elementary N (n)	Secondary Math N (n)	Secondary Science N (n)	Technology / Engineering N[a]	Total N (n)
Small	4,735 (417)	1,082 (380)	1,107 (399)	32 (32)	6,956 (1228)
Medium	7,310 (632)	1,558 (547)	1,510 (545)	113 (113)	10,491 (1837)
Large	7,106 (615)	1,647 (578)	1,538 (555)	191 (191)	10,482 (1939)
Total	19,151 (1664)	4,287 (1505)	4,155 (1499)	336 (336)	27,929 (5004)

[a]All technology and engineering teachers were included in the sample

Note: In the ( ) is the number of individuals in each group that were randomly selected to participate, in order to achieve the required sample size based on a 40% response rate. The required sample size was estimated based on population size, 4% margin of error, and 95% confidence level.

Survey Distribution and Data Collection

ARC staff received a list of teacher contact information from DESE for all elementary teachers, all secondary math teachers, all secondary science teachers, and all technology and engineering teachers. This list was filtered by district code to include only teachers from traditional public schools (not charter schools or other special districts), and then each teacher was assigned a code based on grade level and subject area. From these groups, a sample of teachers was randomly selected and these teachers were invited to participate in the survey. Because not all teachers had an email address listed with DESE, the survey was offered as both an online and paper survey so that the sample would not be biased toward teachers with email addresses.

After Institutional Review Board (IRB) approval was obtained, an email recruitment letter was sent to those in the sample showing accurate email addresses-- 66% of the elementary teachers and 69% of the secondary teachers. A reminder email was sent to non-respondents. Teachers who did not respond to the online survey (or without an email address) were sent a paper survey at their school address. A final email reminder was sent to all non-respondents a few days before the survey closed.

As approved by IRB, the survey responses were anonymous and results are reported in aggregate and by the subsample groupings. In order to maintain anonymity, the initial online platform was set up so that teachers entered the survey platform, agreed to participate, and then were forwarded to the anonymous survey. This initial entrance to the platform was used to track "respondents" although there was no way to determine if they answered any of the actual survey questions. For elementary teachers, the "anonymous response" software feature was implemented.

Table 4: Survey Administration

Action	Date
Online invitation and link to secondary sample	February 3, 2016
Online reminder to secondary sample	February 12, 2016
Paper survey to secondary sample	February 24, 2016
Final online reminder to secondary sample	March 17, 2016
Online invitation and link to elementary sample	March 9, 2016
Online reminder to elementary sample	March 21, 2016
Paper survey mailed to elementary sample	March 29, 2016
Final online reminder sent to elementary sample	April 28, 2016
All surveys closed	May 3, 2016

Note: On March 1, 2016 it came to the ARC's attention that there was an error in sampling for the elementary teachers. The responses from all elementary teachers in the first sample are not reported and a new sample was recruited to participate in the survey with the initial sample removed from the population.

Respondents

Secondary teachers in mathematics, science, technology, and engineering were combined into one group and were surveyed beginning in February. The sample was reduced to 4,957 once duplicate entries were deleted. More than half (59%) of the respondents teaching in grades 7–12 replied through the online survey (Table 5).

Due to a technical problem with pulling the sample, elementary teachers were not surveyed until March. Although the annual spring testing window did not begin until the first week in April, surveying in March may have reduced the number of elementary teacher respondents as they prepared students for MAP Testing. Another possibility for the lower response rate from elementary teachers could be due to elementary classroom teachers not considering themselves as "STEM" teachers and therefore finding the survey not relevant to their situation.

It is impossible to know if the teacher received either the online or paper survey. Teachers in small districts responded nearly equally using paper or online surveys; however, 42% did not have an email on the list from DESE (Table 5). It bears noting that approximately 10% to 15% of the respondents reported they sometimes or never have reliable access to an internet connection at their school for email and web browsing (Table 43).

Ideally, teachers in the sample should have been contacted several times; however, teachers receiving only paper surveys solely received one survey packet with no reminder packets or post cards. In fact, 32% of the entire sample received only one paper survey with no follow-up reminder. In retrospect, a reminder post card likely would have increased response rates.

Table 5: Online and Paper Respondents

Grade Level	Online Respondents	Paper Respondents	Total Respondents
Elementary	101 46%	120 54%	221 100%
Secondary STEM	332 59%	234 41%	566 100%
Unknown	8 62%	5 38%	13 100%
Total	441 55%	359 45%	800 100%
District Size	**Online Respondents**	**Paper Respondents**	**Total Respondents**
Small	113 49%	118 51%	231 100%
Medium	195 62%	122 38%	317 100%
Large	133 56%	105 44%	238 100%
Unknown	0 0%	14 100%	14 100%
Total	441 55%	359 45%	800 100%

From the 4,957 K–12 STEM teachers in the sample, 800 responses were recorded for an overall response rate of 16% (Table 6). Response rates were also calculated based on grade level, with a slightly higher response rate for secondary teachers (17%) compared to elementary teachers (13%). When looking at district size, the response rate was highest for teachers from small districts (19%).

In order to assess how accurate the data is, given the number of responses for the size of the population, the margin of error was calculated. The survey results, based on responses from 800 STEM teachers, has an overall margin of error of +/- 3.4 percentage points at the 95% confidence level. In educational and social research, a 5% margin of error for categorical variables is considered acceptable (Krejcie & Morgan, 1970[1]). The least reliable data will be for elementary teachers with a margin of error of ±6.6.

Table 6: Response Rates by Grade Level and District Size

Grade Level	Population	Sample	Respondents	Response Rate	Error Margin***
Elementary	19,151	1,660	221	13.3%	± 6.6
Secondary STEM*	8,778	3,297	566	17.2%	± 4.0
District Size	**Population**	**Sample**	**Respondents**	**Response Rate**	**Error Margin*** **
Small	6,956	1,220	231	18.9%	± 6.3
Medium	10,491	1,815	317	17.5%	± 5.4
Large	10,482	1,922	238	12.4%	± 6.3
Total	27,929	4,957	**800	16.1%	±3.4

**Technology and engineering teachers were all considered part of the secondary population and sample.*
***An additional 13 respondents did not indicate their grade level, and 14 respondents did not have a district size but are included in the total count.*
****+/- Error margin at a 95 % Confidence Level.*

In comparing the district size of survey participants and the district size of the population of STEM teachers in Missouri, we can see this characteristic for both the sample and population is similar, suggesting that the findings from this survey can be generalizable to the population of STEM teachers in small, medium, and large districts across the state (Table 7).

[1] Halinski, R. S. & Feldt, L. S. (1970). The selection of variables in multiple regression analyses. Journal of Educational Measurement, 7(3), 151-158.

Table 7: District Size Comparisons

District Size	Population	% of Population	Respondents	% of Respondents
Small	6,956	25%	231	28.9%
Medium	10,491	38%	317	39.6%
Large	10,482	38%	238	29.8%
Total	27,929	100%	*800	100.0%

**An additional 13 respondents did not indicate their grade level, and 14 respondents did not have a district size but are included in the total count.*

Methods of Analysis

The data sets from the online and paper surveys were combined and a series of statistical analyses were performed using SPSS software. Basic frequencies, scaled means, and standard deviations were calculated and are reported. Additionally, a collection of grouping variables based on the teachers' demographic information were created to enable statistical analyses. Analyses of Variance (ANOVA) were conducted to investigate differences in responses between elementary and secondary teachers, and among teachers from small to large districts. Pearson Correlations were computed to investigate linkage between years of teaching experience and responses to the Likert-scale items on the survey. Two-tailed t-tests, assuming equal variances, were used to detect statistically significant differences between secondary math and secondary science teachers' interest in STEM PD topics. Throughout the results section, these statistical tests were used to determine which findings should be included in this report.

Survey Results

The survey results are organized into four sections: 1) Teacher Demographic Information, 2) Participation in and General Perceptions of PD, 3) Level of Importance and Level of Interest in PD Topics, and 4) Level of Access to Technology Resources. The teacher demographic information section shows the breakdown of respondents based on grade level, district size, years of experience, and subject taught. In all subsequent sections, responses to survey items are reported first in the aggregate in descending order (highest to lowest mean scores). When appropriate, the respondent subgroups were used to identify survey items with statistically significant differences in responses between the subgroups.

Teacher Demographic Information

Teachers were shown a grid of four grade levels and four subject areas from which to select their current teaching assignment. Because they were asked to select all that applied, some teachers are included in more than one category. The largest group of respondents teach in grades 9–12 (Table 8). Thirty-five teachers reported teaching grades 7–12.

Sixty-two percent of all respondents report teaching some science as part of their teaching assignment.

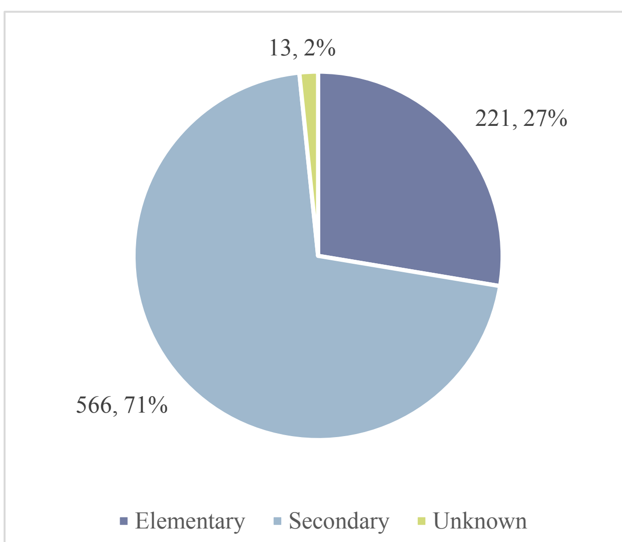
Table 8: Grade Levels and Subjects Taught by Respondents

Grade Level	Total Responses	Percent of All Respondents N=800
Grades K–3	140	17.5%
Grades 4–6	89	11.1%
Grades 7–8	197	24.6%
Grades 9–12	399	49.9%
Mathematics	444	55.5%
Science	499	62.4%
Technology	154	19.3%
Engineering	103	12.9%

Note: Some teachers will be included in more than one category. Responses may not match counts in other tables.

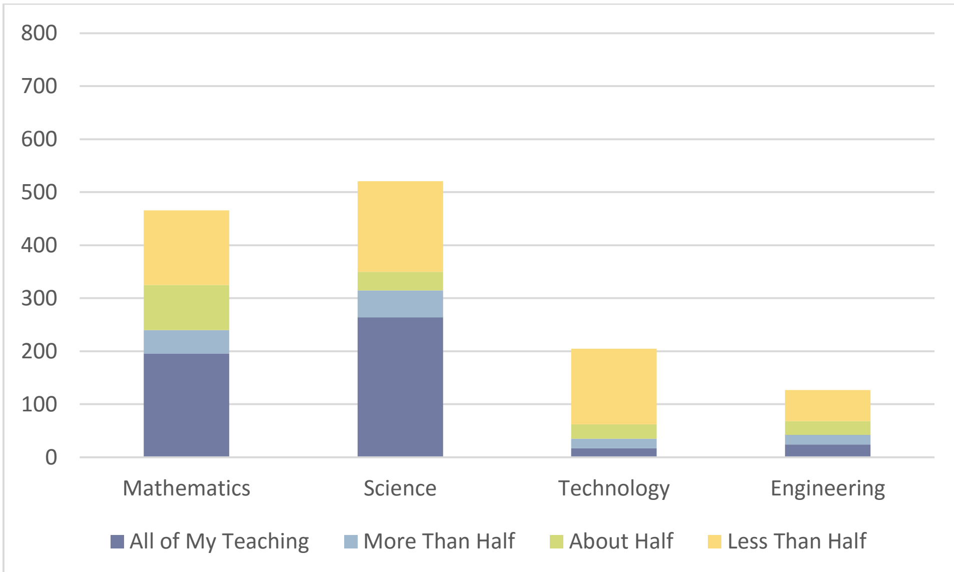
In order to combine teachers into more balanced groups, if teachers indicated teaching grades K–3 or 4–6, they were assigned to the elementary group. If they indicated, they taught grades 7–8 or 9–12, they were assigned to the secondary group. Figure 1 shows that of the 800 respondents, 27% indicated that they taught at the elementary grade level (Grades K–6) and 71% indicated that they taught at the secondary level (Grades 7–12). Two teachers taught grades 4–12 and were included in the secondary group.

Figure 1: Respondent Grade Level Currently Teaching



A subsequent question asked teachers what *proportion* of their teaching was in each STEM subject area. Figure 2 and Table 9 show the proportion of respondents' current teaching assignment for each of the STEM subjects.

Figure 2: Proportion of Teaching and Subject(s) Taught



Respondents selecting the response choice, a*ll of my teaching*, are believed to exclusively teach that subject area. In the elementary grade level, only a small number of respondents exclusively taught mathematics (n = 25), science (n = 20), technology (n = 9), or engineering (n = 3). As to be expected, more secondary teachers exclusively taught mathematics (n = 171) or science (n = 244) compared to respondents teaching at the elementary level (Table 9).

Table 9: Proportion of Teaching and Subject(s) Taught by Grade Level

Elementary (n=221)				
Proportion of Teaching	**Mathematics**	**Science**	**Technology**	**Engineering**
All of My Teaching	25	20	9	3
More Than Half	16	9	3	2
About Half	60	17	11	4
Less Than Half	101	147	86	16
Total	202	193	109	25
Secondary (n=566)				
Proportion of Teaching	**Mathematics**	**Science**	**Technology**	**Engineering**
All of My Teaching	171*	244*	8	21
More Than Half	28	42	15	16
About Half	25	18	16	22
Less Than Half	39	24	57	43
Total	263	328	96	102

** These secondary math teachers and secondary science teachers are used for comparison purposes regarding interest in PD topics.*

Later in this report, when assessing interest in PD topics, these full-time secondary mathematics teachers and full-time secondary science teachers were used as a subgroup to find possible differences in levels of interest in specific topics. Teachers who indicated a mixed teaching assignment or were in a small peer group (i.e., technology teachers and engineering teachers) were not included in the statistical analysis of PD interest by subject taught.

Table 10 shows the number and percentage of respondents who indicated they teach a STEM area at the elementary or secondary levels. Interestingly, 49% of elementary teachers indicated that they teach some technology, compared to only 17% of the secondary teachers. Because there was considerable overlap between these groups, the subject(s) taught were not used as grouping variables for statistical analysis.

Table 10: Respondent Subject(s) Taught by Grade Level

Subject(s) Taught	Elementary (n=221)	Secondary (n=566)	Total (N=787)
Mathematics	202 91.4%	263 46.5%	465 59.1%
Science	193 87.3%	328 58.0%	521 66.2%
Technology	109 49.3%	96 17.0%	205 26.1%
Engineering	25 11.3%	102 18.0%	127 16.1%

Note: Percentages will not add to 100 because teachers were asked to indicate all subjects taught. 13 respondents did not indicate a grade level.

When asked about the proportion of their teaching assignment in regards to STEM subjects, responses varied across subjects and grade levels. For example, 62 teachers in Grades 9–12 selected engineering as their current teaching assignment, 61 stated they taught engineering as a proportion of their teaching assignment and 19 teachers reported all of their teaching was in engineering (Table A-4). In Appendix A are four detailed tables showing the initial responses for the two questions asking respondents to report their teaching assignments and proportion for each STEM subject. These tables report on each grade level, i.e., Table A-1, grades K–3 through Table A-4, grades 9–12.

The respondent's school district size was assigned (described on pages 7–8) and 30% of respondents came from large districts, 39% came from medium districts, and 29% came from small districts (Figure 3 and Table 11). Because of an error in data cleaning of the paper survey, we were not able to assign district size for the 14 respondents with an unknown district size.

Figure 3: Respondent School District Size

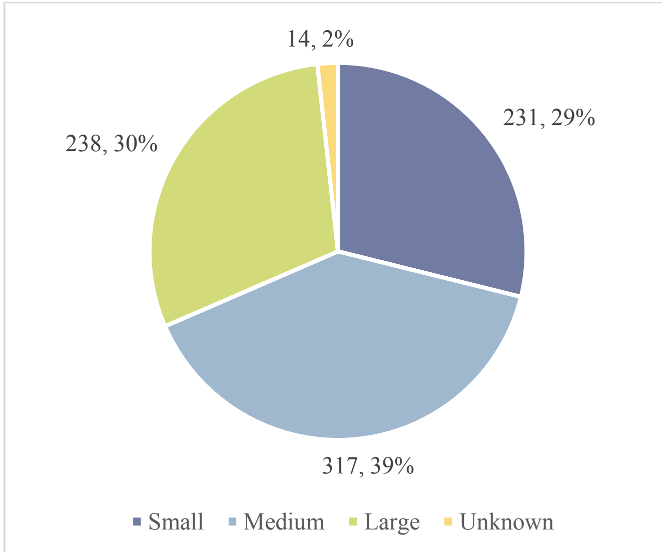


Table 11: Distribution of Respondents by District Size and Grade Level

District Size	Grade Level			Total
	Elementary	Secondary	Unknown	
Small	57	167	7	231 (28.9%)
Medium	88	226	3	317 (39.6%)
Large	75	161	2	238 (29.8%)
Unknown	1	12	1	14 (1.8%)
Total	221	566	13	800 (100.0%)

Note: If teachers indicated teaching grades K–3 or 4–6, they were assigned to the elementary group. If they indicated, they taught grade 7–8 or 9–12, they were assigned to the secondary group. District size assignment was determined based on data from DESE regarding number of students and number of teachers as described in the methods section.

The MO-STEM PD needs assessment also gave teachers six options for them to indicate the number of years they had taught at the K–12 level. Table 12 shows the number of respondents and their years of teaching experience. There was a relatively even distribution of teachers between their years of experience, though the largest group of respondents has taught for over 20 years (23%).

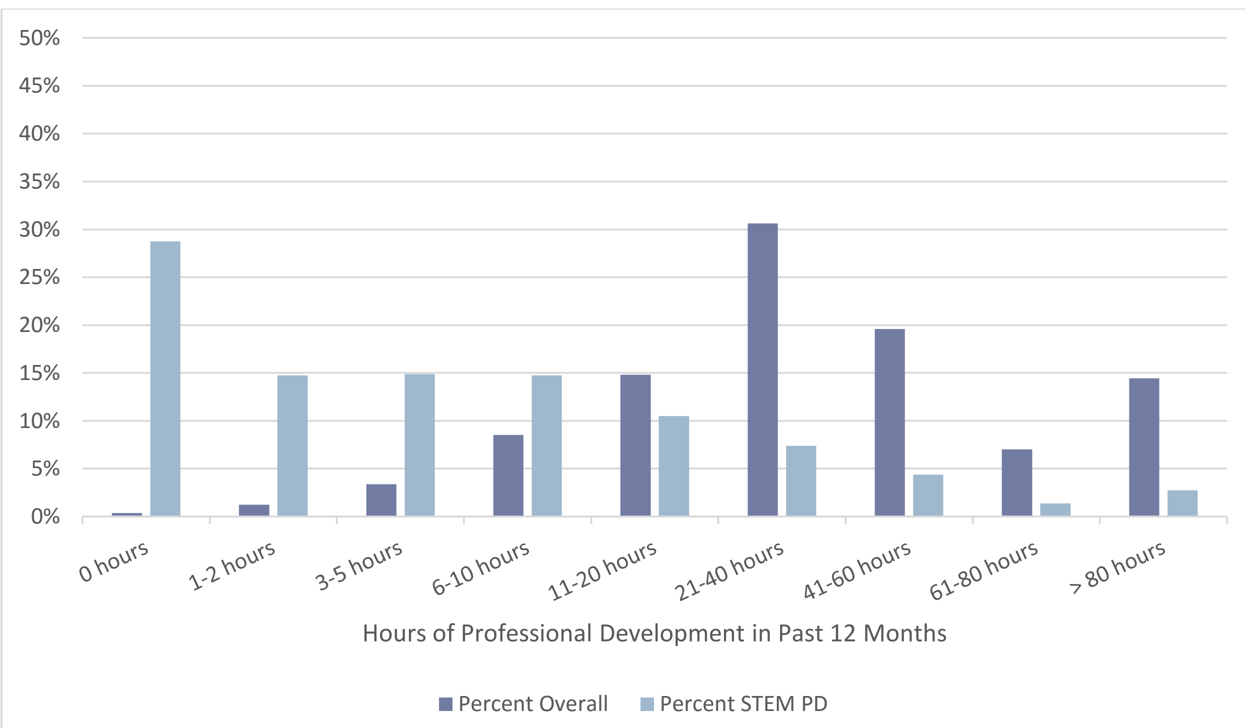
Table 12: Years of Teaching Experience

Years of Experience	Respondents	Percent
0–5 years	145	18.2%
6–10 years	173	21.7%
11–15 years	156	19.6%
16–20 years	142	17.8%
Over 20 years	181	22.7%
Total	797	100.0%

Participation in Professional Development

In order to approximate the current level of participation in PD in general and STEM PD in particular, participants were given nine time ranges and were asked to select the range that indicated the number of hours of PD they participated in during the past 12 months. Figure 4 shows that just over 30% of respondents participated in 21–40 hours of PD during the last year. However, regarding STEM PD participation, nearly 30% indicated that they did *not* participate in any STEM PD at all.

Figure 4: Levels of Participation in Professional Development



The size of a teacher's district made a difference in the amount of both overall and STEM PD attended by respondents. Scaled mean scores were calculated to compare teachers' amount of overall PD and STEM PD across the subgroups. The responses were scored on a scale of 1–9 (1=0 hours, 2=1–2 hours, 3=3–5 hours, 4=6–10 hours, 5=11–20 hours, 6=21–40 hours, 7=41–60 hours, 9=61–80 hours, and 9= more than 80 hours). An ANOVA indicated that there were significant differences between district size subgroups in terms of hours of PD attended (p-value < .05) (Table 13). As district size increased, so did participation in PD. Teachers from small, medium, and large districts had scaled mean overall PD scores of 6.0, 6.4, and 6.4 respectively, representing approximately 21–40 hours of overall PD.

Table 13: Differences in Mean PD Scores by District Size

District Size	Responses	Mean	SD
Small	230	6.01	1.7
Medium	317	6.37	1.6
Large	236	6.42	1.7
Total	783	6.28	1.7

The responses were scored on scale of 1–9 with 1=0 hours, 2=1–2 hours, 3=3–5 hours, 4=6–10 hours, 5=11–20 hours, 6=21–40 hours, 7=41–60 hours, 9=61–80 hours, and 9=more than 80 hours.

Appendix B reports on the ranges of PD hours for each district size. Table B-1 shows the percentages of respondents reporting each range of PD hours for the past 12 months of PD overall. Table B-2 reports the amount of STEM PD by the ranges of hours and by the size of the teacher's district.

There were significant differences in the number of hours of STEM PD attended by respondents in the past 12 months by district size (*p-value* < .001). As district size increased, participation in STEM PD also increased (Table 14). Teachers from small, medium, and large districts had scaled mean STEM PD scores of 2.9, 3.2, and 3.7, respectively.

Table 14: Differences in STEM PD Mean Scores by District Size

District Size	Responses	Mean	SD
Small	230	2.87	1.9
Medium	317	3.24	2.2
Large	235	3.66	2.2
Total	782	3.26	2.1

Additionally, there were significant differences in the number of hours of STEM PD attended by respondents in the past 12 months by their grade level (*p-value* < .001). Table 15 shows that secondary teachers (mean = 3.5) indicated a higher level of participation in STEM PD than elementary teachers (mean = 2.7).

Table 15: Differences in STEM PD Mean Scores by Grade Level

Grade Level	Responses	Mean	SD
Elementary	220	2.67	1.8
Secondary	563	3.50	2.2
Total	783	3.27	2.1

The responses were scored on scale of 1–9 with 1=0 hours, 2=1–2 hours, 3=3–5 hours, 4=6–10 hours, 5=11–20 hours, 6=21–40 hours, 7=41–60 hours, 9=61–80 hours, and 9=more than 80 hours.

Table 16 shows the scaled mean scores for participation in overall PD and STEM PD by years of teaching experience. Pearson Correlations did not indicate a significant correlation between years of teaching experience and participation in PD or STEM PD.

Table 16: Overall PD and STEM PD Mean Scores by Years of Teaching Experience

Teaching Experience	Overall PD			STEM PD		
	Responses	Mean	SD	Responses	Mean	SD
0–5 years	145	6.34	1.6	144	3.17	1.8
6–10 years	173	6.50	1.6	172	3.53	2.2
11–15 years	155	6.40	1.7	156	3.26	2.2
16–20 years	142	5.89	1.6	142	2.90	2.0
Over 20 years	179	6.23	1.7	179	3.39	2.3
Total	794	6.28	1.7	793	3.27	2.1

The responses were scored on scale of 1–9 with 1=0 hours, 2=1–2 hours, 3=3–5 hours, 4=6–10 hours, 5=11–20 hours, 6=21–40 hours, 7=41–60 hours, 9=61–80 hours, and 9=more than 80 hours.

Professional Development Preferences

Teachers were asked four sets of questions regarding their preferences for professional development. The first set of questions centered on their PD environment. The second set of questions asked the importance of certain PD activities. The final two sets of questions focused on possible timeframes and modes of PD delivery. Results varied by teacher demographics.

Professional Development Environment

Teachers were asked to indicate their level of agreement with seven statements related to STEM PD and their teaching environment and were given five response choices (1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree). For each statement, scaled mean scores were calculated and are shown in Table 17.

Respondents expressed interest in attending STEM PD to improve instructional practices (mean = 4.2), believed that attending STEM PD would help improve their teaching (mean = 4.2), and indicated that STEM PD access can potentially benefit students in their school (mean = 4.2).

Statements in Table 15 showing significant differences between subgroups are indicated with subscripts and are reported individually in subsequent tables.

Table 17: Mean Scores of Teacher Perceptions of STEM PD

Statements Regarding STEM PD	Responses	Mean	SD
I would like to attend PD for STEM teaching and learning to improve my instructional practices.	797	4.23	0.8
My participation in STEM PD would help to improve my teaching. c***	794	4.21	0.7
The students in my school stand to benefit from STEM PD available to our teachers.	797	4.20	0.7
STEM PD would be received positively within my school. a*	798	3.92	0.8
I have support from my principal to pursue PD for STEM teaching and learning. b*	797	3.84	0.9
I am able to adopt or adapt strategies learned from STEM PD programs into my teaching practice. b**	795	3.62	0.9
Quality PD programs for STEM teaching and learning are readily available to me.	795	2.79	1.0

*a Significant difference between small, medium, and large district sizes (ANOVA, *p-value <.05, **p-value<.01)*
*b Significant differences between elementary and secondary teachers (ANOVA, *p-value <.05, **p-value<.01)*
*c Significant differences between years of teaching experience (Pearson Correlation, *** p-value<.001)*

Regarding teacher interest in attending STEM PD to improve instruction, an ANOVA indicated that there were significant differences based on the teacher's district size (*p-value* < .05), with teachers from large districts reporting higher levels of agreement with the statement compared to teachers from small- and medium-sized districts (Table 18).

Table 18: Differences in Perceptions of STEM PD by District Size

Statement Regarding STEM PD	District Size	Responses	Mean	SD
STEM professional development would be received positively within my school.*	Small	230	3.80	.81
	Medium	316	3.93	.80
	Large	238	4.03	.82
	Total	784	3.92	.81

**ANOVA, p-value <.05*

As might be expected, less experienced teachers were more likely to indicate a higher level of interest in attending STEM PD to improve their instruction (Table 19). A Pearson Correlation indicated that as teaching experience increased, mean scores decreased (*p-value* < .001).

Table 19: Differences in Perceptions of STEM PD by Years of Teaching Experience

Statement Regarding STEM PD	Years of Experience	Responses	Mean	SD
My participation in STEM professional development would help to improve my teaching.***	0–5 years	145	4.34	0.7
	6–10 years	170	4.28	0.7
	11–15 years	155	4.30	0.6
	16–20 years	141	4.16	0.7
	Over 20 Yrs.	180	4.02	0.7
	Total	791	4.21	0.7

****Pearson Correlation, p-value <.001*

Respondents teaching in grades 7–12 indicated a higher level of agreement with the statement, "I have support from my principal to pursue professional development for STEM teaching and learning" than did respondents teaching at the elementary level (Table 18). An ANOVA indicated that there were significant differences in agreement with this statement based on grade level (*p-value* < .05).

Additionally, respondents teaching at the secondary level were more likely to indicate that they are able to adopt or adapt STEM PD strategies in their teaching that they learned from STEM PD than are respondents teaching at the elementary level (*p-value* < .01) (Table 20).

Table 20: Perceptions of STEM PD by Grade Level

Statements Regarding STEM PD	Grade Level	Responses	Mean	SD
I have support from my principal to pursue professional development for STEM teaching and learning.*	Elementary	221	3.72	1.0
	Secondary	563	3.88	0.9
	Total	784	3.83	0.9
I am able to adopt or adapt strategies learned from STEM professional development programs into my teaching practice.**	Elementary	220	3.45	0.9
	Secondary	562	3.69	0.9
	Total	782	3.62	0.9

**ANOVA, p-value <.05, **ANOVA, p-value <.01*

Importance of Professional Development Activities

Teachers were shown eight statements related to PD programs and activities and asked to indicate the level of importance of each aspect to them. For each statement, scaled mean scores were calculated from the response choices (1 = Not Important, 2 = Slightly Important, 3 = Moderately Important, 4 = Very Important, 5 = Extremely Important) and are shown in Table 21.

Respondents indicated the importance to them of accessing ready-to-use materials (mean = 4.2), learning from other teachers (mean = 4.1), and learning about new and innovative teaching strategies (mean = 4.1). Respondents also indicated that meeting PD requirements for their school or district was the least important of the eight aspects (mean = 3.19). There were significant differences in responses to these items based on grade level, district size, and years of experience. These significant differences or significant correlations are indicated with subscripts in Table 21 and are reported in subsequent tables.

Table 21: Importance of Aspects of PD Programs

Aspects of PD Programs	Responses	Mean	SD
Accessing ready-to-use materials	774	4.21	0.9
Learning from other teachers	776	4.07	0.7
Learning about new and innovative teaching strategies $_{a***}$	773	4.05	0.8
Learning from experts in the field $_{a**}$	776	4.01	0.8
Learning about new ideas emerging from STEM fields	772	3.94	0.9
Networking with other teaching professionals	773	3.90	0.9
Receiving feedback on teaching practices $_{a**,\ c***}$	776	3.73	0.9
Meeting PD requirements from my school or district $_{b*,\ a***,\ c***}$	774	3.19	1.2

$_a$ *Significant differences based on grade level (ANOVA, **p-value < .01, ***p-value < .001)*
$_b$ *Significant differences based on district size (ANOVA, * p-value < .05)*
$_c$ *Significant difference based on years of teaching experience (Pearson Correlation, ***p-value < .001)*

For four of the statements in Table 19, an ANOVA indicated that there were statistically significant differences between respondents teaching at the elementary and secondary levels in terms of their perceived level of importance of different aspects of PD programs (Table 22).

Elementary teachers indicated that learning about new and innovative teaching strategies was more important (mean = 4.3) than did secondary teachers (mean = 4.0).

Additionally, elementary respondents indicated that attending PD programs was more important for them to meet professional development needs for their school or district (mean = 3.7) compared to secondary teachers (mean=3.0). These results may suggest that there are different expectations for professional development for elementary and secondary teachers.

Table 22: Differences in Importance of Aspects of PD Programs by Grade Level

Aspects of PD Programs	Grade Level	Responses	Mean	SD
Learning about new and innovative teaching strategies***	Elementary	205	4.30	0.7
	Secondary	557	3.96	0.9
	Total	762	4.06	0.8
Learning from experts in the field**	Elementary	209	4.13	0.8
	Secondary	556	3.96	0.8
	Total	765	4.01	0.8
Receiving feedback on teaching practices**	Elementary	209	3.89	0.9
	Secondary	556	3.67	0.9
	Total	765	3.73	0.9
Meeting professional development requirements from my school or district***	Elementary	207	3.72	1.1
	Secondary	556	2.99	1.2
	Total	763	3.18	1.2

*ANOVA, **p-value < .01, ***p-value < .001)*

Meeting PD requirements for their school or district was also significantly different depending on the respondent's district size. An ANOVA (p-value>.05) indicated that teachers from small districts ranked meeting PD requirements for their school or district as more important (mean = 3.4) than respondents from medium (mean = 3.2) or large districts (mean = 3.1) (Table 23).

Table 23: Differences in Importance of PD Requirements by District Size

Aspect of PD Programs	District Size	Responses	Mean	SD
Meeting PD requirements from my school or district*	Small	223	3.39	1.1
	Medium	309	3.16	1.2
	Large	228	3.07	1.3
	Total	760	3.20	1.2

*ANOVA, *p-value < .05*

The importance of meeting school or district PD requirements also showed significant differences based on years of teaching experience. Pearson Correlations indicated statistically significant and negative correlations (*p-value* < .001) between years of teaching experience and respondents' perceived importance of two aspects of PD. Mean scores show that less experienced teachers perceived both receiving feedback on teaching practices and meeting professional development requirements for their school or district as more important aspects of a PD program than did more experienced teachers (Table 24).

Table 24: Differences in Importance of Aspects of PD by Years of Experience

Aspects of PD Programs	Years of Experience	Responses	Mean	SD
Receiving feedback on teaching practices***	0–5 years	138	4.04	0.9
	6–10 years	169	3.83	0.8
	11–15 years	151	3.71	1.0
	16–20 years	138	3.66	0.9
	Over 20 Yrs.	177	3.50	1.0
	Total	773	3.74	0.9
Meeting professional development requirements from my school or district***	0–5 years	137	3.56	1.1
	6–10 years	168	3.32	1.1
	11–15 years	151	3.05	1.3
	16–20 years	138	3.14	1.2
	Over 20 Yrs.	177	2.97	1.2
	Total	771	3.20	1.2

****Pearson Correlation, p-value <.001*

Timeframe of Delivery of Professional Development Programs

Respondents were given a list of ten possible timeframes of PD program delivery and were asked to indicate their level of interest in attending each delivery timeframe using a three-point scale. The scaled mean scores were calculated (not interested = 1, possibly interested = 2, and definitely interested = 3). Table 25 shows the mean scores representing the respondents' interest in the timeframe of PD delivery from highest to lowest score. Teachers were most interested in one-time, half-day workshops (mean = 2.4) and one-time, all-day workshops (mean = 2.4). Teachers were least interested in intensive summer trainings (mean = 1.9) and weekend trainings (mean = 1.6). Statistical analyses indicated that there were significant differences in level of interest based on grade level and years of teaching experience. These significant differences or significant correlations are indicated with subscripts in Table 25 and are explored in the subsequent tables.

Table 25: Teacher Interest in PD Program Delivery Formats

Delivery of PD Programs	Responses	Mean	SD
One-time, half day workshops [c***]	774	2.41	0.6
One-time, all day workshops [c***]	767	2.41	0.6
Training or workshops during school hours [a**, c***]	776	2.32	0.6
Ongoing support programs	776	2.32	0.6
One-time, short workshops (1–2 hours) [a**, c***]	771	2.31	0.7
Recurring sessions during school hours [a***]	773	2.08	0.7
Recurring sessions outside of school hours [a*]	771	1.95	0.6
Intensive summer workshops (1–2 weeks) [a***]	771	1.90	0.7
Weekend trainings [a***]	768	1.57	0.7

*[a] Significant differences based on grade level (ANOVA, **p-value < .01, ***p-value < .001)*
*[b] Significant difference based on years of teaching experience (Pearson Correlation, ***p-value < .001)*

ANOVA indicated that there were significant differences between elementary and secondary teachers' interest in different formats of PD delivery (Table 26). Elementary teachers were more interested in recurring sessions during school hours (mean = 2.3) than were secondary teachers (mean = 2.0; *p-value* < .001). Though the level of interest was relatively low for attending intensive summer workshops and weekend trainings, secondary teachers were more interested in these formats compared to elementary teachers (*p-value* < .001).

Table 26: Differences in Interest of PD Delivery by Grade Level

Delivery of PD Programs	Grade Level	Responses	Mean	SD
Training or workshops during school hours**	Elementary	209	2.43	0.6
	Secondary	556	2.27	0.6
	Total	765	2.31	0.6
One-time, short workshops (1–2 hours)**	Elementary	207	2.42	0.6
	Secondary	553	2.27	0.7
	Total	760	2.31	0.7
Recurring sessions during school hours***	Elementary	209	2.25	0.7
	Secondary	553	2.01	0.7
	Total	762	2.07	0.7
Recurring sessions outside of school hours*	Elementary	207	1.86	0.7
	Secondary	554	1.99	0.6
	Total	761	1.95	0.7
Intensive summer workshops (1–2 weeks)***	Elementary	207	1.68	0.7
	Secondary	553	1.99	0.7
	Total	760	1.90	0.7
Weekend trainings***	Elementary	220	1.39	0.9
	Secondary	562	1.65	0.9
	Total	782	1.58	0.9

*ANOVA, *p-value<.05, **p-value < .01, ***p-value < .001*

Pearson Correlations suggested a significant correlation (*p-values* < .001) between years of teaching experience and level of interest for four different formats of PD delivery (Table 27). Across all of these formats, teachers with fewer years of experience indicated a higher level of interest than more experienced teachers.

Table 27: Differences in Interest in PD Delivery by Years of Experience

Delivery of PD Programs	Years of Experience	Responses	Mean	SD
One-time, half day workshops***	0–5 years	137	2.52	0.6
	6–10 years	169	2.47	0.6
	11–15 years	151	2.40	0.6
	16–20 years	138	2.40	0.6
	Over 20 Yrs.	176	2.28	0.6
	Total	771	2.41	0.6
One-time, all day workshops***	0–5 years	137	2.51	0.6
	6–10 years	169	2.46	0.6
	11–15 years	150	2.43	0.6
	16–20 years	134	2.39	0.6
	Over 20 Yrs.	174	2.26	0.7
	Total	764	2.41	0.6
Training or workshops during school hours***	0–5 years	138	2.41	0.6
	6–10 years	169	2.37	0.6
	11–15 years	150	2.33	0.6
	16–20 years	138	2.36	0.6
	Over 20 Yrs.	178	2.14	0.7
	Total	773	2.32	0.6
One-time, short workshops (1–2 hours) ***	0–5 years	137	2.45	0.6
	6–10 years	169	2.38	0.6
	11–15 years	149	2.28	0.7
	16–20 years	137	2.30	0.7
	Over 20 Yrs.	176	2.16	0.7
	Total	768	2.31	0.7

*Pearson Correlation, ***p-value < .001)*

Format of Professional Development Programs

The next set of ten items on the survey asked teachers to use a three-point scale to indicate their level of interest in participating in a variety of modes of PD, i.e., on-site, off-site, and virtual ways. The scaled mean scores were calculated for each of the items (not interested = 1, possibly interested = 2, and definitely interested = 3). These mean scores are reported in Table 28 from highest-to-lowest score.

Respondents were most interested in attending face-to-face programs offered at their school site (mean = 2.6). Teachers indicated a higher level of interest in all of the face-to-face PD formats compared to all of the hybrid situations having less direct contact with other teachers/trainers. The formats of least interest are through virtual trainings (mean = 2.0), self-paced online PD (mean = 1.9), and through online forums (mean=1.8). Statistical analyses indicated that there were significant differences in levels of interest in different formats of PD delivery based on the teachers' grade level, district size, and years of experience. These significant differences or significant correlations are indicated with subscripts in Table 28 and are explored in the following tables.

Table 28: Interest in Formats of Professional Development Delivery

PD Formats	Type	Responses	Mean	SD
Attending face-to-face programs offered at my school site $_{b**}$	On-site	774	2.55	0.6
Traveling to face-to-face programs offered in my district or region $_{a**,c***}$	Off-site	772	2.42	0.6
Collaborating with other teachers in my school/district in a Professional Learning Community $_{b*,c***}$	On-site	773	2.38	0.6
Observing an expert teacher working in his/her own classroom $_{a**}$	On-/Off-site	771	2.30	0.6
Traveling to face-to-face programs offered at central locations $_{a***,\ b*,\ c***}$	Off-site	773	2.20	0.7
Receiving mentorship from an expert teacher in my subject area	All	773	2.14	0.7
Participating in the hybrid model that incorporates some face-to-face time with online follow-up opportunities $_{a**,\ c***}$	All	774	2.10	0.7
Viewing virtual trainings and webinars	Virtual	772	1.97	0.7
Completing online, self-paced learning modules	Virtual	769	1.92	0.8
Using online communities and forums like discussion boards, wikis, and/or blogs $_{c***}$	Virtual	769	1.75	0.7

$_a$ *Significant differences based on grade level (ANOVA, **p-value < .01, ***p-value < .001)*
$_b$ *Significant differences based on district size (ANOVA, * p-value < .05)*
$_c$ *Significant difference based on years of teaching experience (Pearson Correlation, 2-tailed significance, ***p-value < .001)*

An ANOVA found that there were significant differences in levels of interest in the different PD formats based on respondents' grade level. Secondary teachers were more interested in traveling to face-to-face programs in their district or region, traveling to face-to-face programs in central locations, and participating in hybrid PD than elementary teachers (see Table 29). Elementary teachers reported higher levels of interest in observing an expert teacher than their secondary counterparts.

Table 29: Differences in Interest in PD Formats by Grade Level

Formats of PD Programs	Grade Level	Responses	Mean	SD
Traveling to face-to-face programs offered in my district or region**	Elementary	205	2.30	0.6
	Secondary	556	2.46	0.6
	Total	761	2.42	0.6
Observing an expert teacher working in his/her own classroom**	Elementary	205	2.41	0.6
	Secondary	556	2.26	0.7
	Total	761	2.30	0.6
Traveling to face-to-face programs offered at central locations (e.g., St. Louis, Kansas City, Springfield, Columbia)***	Elementary	205	2.00	0.7
	Secondary	557	2.27	0.6
	Total	762	2.20	0.7
Participating in the hybrid model that incorporates some face-to-face time with online follow-up opportunities**	Elementary	207	1.98	0.7
	Secondary	556	2.13	0.6
	Total	763	2.09	0.7

*ANOVA, **p-value < .01, ***p-value < .001)*

Responses show that teachers had differing levels of interest in relationship to the size of their district. Teachers from large districts indicated a higher level of interest in attending face-to-face programs at their school site (mean = 2.63) compared with teachers from medium (mean = 2.55), or small districts (mean = 2.46) (Table 30). Similarly, teachers from larger districts reported a higher level of interest in collaborating with other teachers in their school or district in a Professional Learning Community (mean = 2.47), compared with teachers from medium (mean = 2.38), or small districts (mean = 2.29). Teachers from smaller districts were the least interested in traveling to face-to-face programs at centralized, more urban locations (mean = 2.11).

Table 30: Differences in Interest in PD Formats by District Size

Formats of PD Programs	District Size	Responses	Mean	SD
Attending face-to-face programs offered at my school site**	Small	222	2.46	0.6
	Medium	310	2.55	0.6
	Large	228	2.63	0.5
	Total	760	2.55	0.6
Collaborating with other teachers in my school/district in a Professional Learning Community*	Small	222	2.29	0.6
	Medium	310	2.38	0.6
	Large	227	2.47	0.6
	Total	759	2.38	0.6
Traveling to face-to-face programs offered at central locations (e.g., St. Louis, Kansas City, Springfield, Columbia)*	Small	222	2.11	0.7
	Medium	309	2.25	0.6
	Large	228	2.22	0.7
	Total	759	2.20	0.7

*ANOVA, * p-value < .05, **p-value < .01*

For five of the different formats of PD programs, there was a statistically significant correlation between years of teaching experience and level of interest in the type of format (*p-values* < .001) (Table 31). Teachers with fewer years of teaching experience indicated a higher level of interest in all of these four areas. The most noteworthy example is that teachers with 0–5 years of teaching experience indicated a mean interest level of 2.4 for participating in the hybrid model of PD that incorporates some face-to-face time with online follow-up opportunities, while teachers with over 20 years of teaching experience had a mean interest level of just 1.9 for the hybrid model.

Table 31: Differences in Interest in PD Formats by Years of Experience

Formats of PD Programs	Years of Experience	Responses	Mean	SD
Traveling to face-to-face programs offered in my district or region***	0–5 years	138	2.55	0.5
	6–10 years	169	2.43	0.6
	11–15 years	149	2.47	0.6
	16–20 years	135	2.36	0.6
	Over 20 Yrs.	178	2.29	0.6
	Total	769	2.42	0.6
Collaborating with other teachers in my school/district in a Professional Learning Community***	0–5 years	138	2.54	0.6
	6–10 years	168	2.51	0.5
	11–15 years	149	2.30	0.7
	16–20 years	137	2.39	0.6
	Over 20 Yrs.	178	2.20	0.7
	Total	770	2.38	0.6
Traveling to face-to-face programs offered at central locations (e.g., St. Louis, Kansas City, Springfield, Columbia)***	0–5 years	137	2.30	0.7
	6–10 years	169	2.24	0.6
	11–15 years	149	2.25	0.7
	16–20 years	137	2.18	0.6
	Over 20 Yrs.	178	2.04	0.6
	Total	770	2.20	0.7
Participating in the hybrid model that incorporates some face-to-face time with online follow-up opportunities***	0–5 years	137	2.40	0.6
	6–10 years	168	2.31	0.7
	11–15 years	149	2.13	0.7
	16–20 years	138	2.04	0.6
	Over 20 Yrs.	178	1.87	0.7
	Total	770	2.14	0.7
Using online communities and forums like discussion boards, wikis, and/or blogs ***	0–5 years	137	1.86	0.7
	6–10 years	167	1.87	0.7
	11–15 years	148	1.79	0.8
	16–20 years	137	1.72	0.7
	Over 20 Yrs.	177	1.56	0.7
	Total	766	1.75	0.7

*Pearson Correlation, 2-tailed significance, ***p-value < .001*

Professional Development Topic Areas

The MO-STEM Needs Assessment asked teachers to indicate the level of importance of, and level of interest in, attending PD related to 22 topics. Teachers were given a 4-point scale to rate the topic's importance to them and were given a 3-point scale to indicate their level of interest in attending PD on that topic. Scaled mean scores were calculated for importance of topic (1 = not important, 2 = slightly important, 3 = moderately important, 4 = very important) and level of interest in that topic (1 = not interested, 2 = possibly interested, 3 = definitely interested). The mean scores are reported in Table 32, which is organized from highest mean to lowest mean for their perceived importance of the topic.

Using real world issues in the classroom was perceived to be the most important topic (mean = 3.6) and teachers also reported the highest level of interest in attending PD on this topic (mean = 2.6). Problem-based learning was the second most-selected PD topic for both importance and interest (means = 3.5 and 2.5).

The lowest scores for importance were on the Next Generation Science Standards, engineering design practices, and Common Core State Standards for math, with mean scores of 2.7, 2.7, and 2.4 respectively.

Statistical analyses showed that there were significant differences in perceived importance of these topics and interest in attending PD on these topics based on the teachers' grade level, district size, and years of teaching experience. These significant differences or significant correlations are indicated with subscripts in Table 30. In the subsequent tables, the highly significant differences (*p-values* $< .001$) in level of interest between these subgroups are explored in greater detail.

There were also differences between responses from secondary science and secondary mathematics teachers; these differences are noted in Tables 40–42.

In Appendix C, Table C-1 shows the order of the topics in relationship to respondents' interest in attending PD. Though not included in this report, the analysis between subgroups indicated that the rank order of items based on importance or interest depends greatly on grade level, school size, or years of teaching experience. Therefore, it might be important to consider these different priorities when designing PD programs targeting particular teacher populations.

Additional factor analysis might show natural groupings in terms of the perceived importance and interest in these PD topics. This further analysis might also help design PD programs, which may include clustered PD items.

Table 32: Importance of, and Interest in, PD Topics

Professional Development Topics	Importance			Interest		
	N	Mean	SD	N	Mean	SD
Using real-world issues in the classroom	749	3.59 c***	0.6	728	2.59 a***, c***	0.6
Problem-based learning	740	3.46 c***	0.7	717	2.5 c***	0.6
Use of educational technologies to support learning	749	3.45 a**	0.7	729	2.45	0.6
Instructional strategies for meeting the needs of diverse learners	750	3.37 a***, c***	0.7	728	2.31 a*, c***	0.7
Integrating science, technology, engineering, and math	750	3.37	0.8	728	2.44	0.6
Mathematical practices	749	3.30 a***	0.8	727	2.16 a***	0.8
Inquiry-based laboratory activities	748	3.26 a**, b*	0.9	723	2.37 a*	0.7
Strategies for student use of mobile technologies	751	3.24	0.8	728	2.38	0.7
Aligning instruction and curriculum with standards	744	3.24 a***, c***	0.9	724	2.16 a***	0.8
Integrating literacy practices with STEM learning	748	3.12 a***	0.9	726	2.18 a***, c***	0.7
Supporting girls and minorities in STEM	746	3.09 a*, b***	1.0	723	2.17 a**, b*	0.8
Scientific practices (e.g., modeling and argumentation)	747	3.09 a*	0.9	721	2.14 a*	0.7
New Missouri learning standards	745	3.08 a***,b**	0.9	727	2.16 a*** ,b**	0.7
Formative assessment for STEM learning	745	3.02 a**	0.8	723	2.18 b**, c***	0.7
Integrating authentic STEM research into the classroom	745	3.01 c***	0.9	729	2.32 a**	0.7
Interdisciplinary STEM teaching	744	2.95 a*, c***	0.9	717	2.20 c***	0.7
Supporting classroom discourse	734	2.86 c***	0.8	717	1.99 a**, c***	0.7
Preparing students for achievement tests	749	2.86 b***	1.0	726	1.94 b**	0.8
Analysis of "big data"	741	2.78 a*	0.9	722	1.95 a***	0.7
Next Generation Science Standards	743	2.68 a***	1.0	721	1.88 a***	0.8
Engineering design practices	743	2.67 a***, b*	1.0	727	1.99 a***	0.8
Common Core State Standards for Mathematics	743	2.64 a***	1.0	724	1.80 a***	0.8

[a] *Significant differences based on grade level (ANOVA, **p-value < .01, ***p-value < .001)*
[b] *Significant differences based on district size (ANOVA, * p-value < .05)*
[c] *Significant difference based on years of teaching experience (Pearson Correlation, p-value < .001)*

Table 33 shows the PD topics that had a highly significant difference between the level of interest reported by elementary and secondary teachers with a *p-value* < .001.

Elementary teachers reported a stronger interest in PD for the following three areas: mathematical practices, aligning instruction and curriculum with standards, and the new Missouri learning standards. It is possible that it is an analytical artifact for several PD topics where the elementary teachers reported a higher level of interest compared to secondary teachers. Because secondary teachers are more likely to only teach science or only teach mathematics, this could make the PD on Next Generation Science Standards (NGSS) or Common Core State Standards for Mathematics (CCSS) for mathematics less interesting for secondary teachers not assigned to teach one of those subjects as well as PD on mathematical practices.

Secondary teachers indicated a higher level of interest compared to elementary teachers in attending PD related to using real world issues in the classroom, analysis of "big data," and engineering design practices.

Table 33: Differences in Interest in STEM PD Topics by Grade Level

PD Topics of More Interest to Elementary Teachers	Grade Level	Responses	Mean	SD
Mathematical practices***	Elementary	191	2.44	0.6
	Secondary	526	2.07	0.8
	Total	717	2.17	0.8
Aligning instruction and curriculum with standards***	Elementary	189	2.44	0.7
	Secondary	525	2.05	0.8
	Total	714	2.15	0.8
New Missouri learning standards***	Elementary	191	2.34	0.7
	Secondary	526	2.10	0.8
	Total	717	2.16	0.7
Next Generation Science Standards***	Elementary	187	2.06	0.8
	Secondary	524	1.81	0.8
	Total	711	1.88	0.8
Common Core State Standards for Mathematics***	Elementary	188	2.10	0.8
	Secondary	526	1.69	0.8
	Total	714	1.79	0.8
PD Topics of More Interest to Secondary Teachers	**Grade Level**	**Responses**	**Mean**	**SD**
Using real-world issues in the classroom***	Elementary	190	2.45	0.6
	Secondary	528	2.64	0.5
	Total	718	2.59	0.6
Analysis of "big data"***	Elementary	191	1.73	0.7
	Secondary	521	2.03	0.7
	Total	712	1.95	0.7
Engineering design practices***	Elementary	192	1.79	0.8
	Secondary	525	2.07	0.8
	Total	717	2.00	0.8

*ANOVA, ***p-value < .001*

An ANOVA indicated that there were highly significant differences in the level of interest in PD topics based on district size regarding four PD topics (Table 34). Teachers from large districts indicated a higher level of interest in attending PD focused on supporting girls and minorities in STEM (mean = 2.3) compared to teachers from medium (mean = 2.2) and small districts (mean = 2.0).

Teachers from small districts reported a higher level of interest in attending PD on new Missouri learning standards, formative assessment for STEM learning, and preparing students for achievement tests compared to teachers from medium or large districts.

Table 34: Differences in Interest in STEM PD topics by District Size

PD Topics	District Size	Responses	Mean	SD
Supporting girls and minorities in STEM***	Small	205	2.03	0.8
	Medium	291	2.20	0.8
	Large	213	2.26	0.7
	Total	709	2.17	0.8
New Missouri learning standards***	Small	207	2.26	0.7
	Medium	293	2.23	0.7
	Large	213	2.01	0.8
	Total	713	2.17	0.7
Formative assessment for STEM learning***	Small	207	2.26	0.6
	Medium	287	2.21	0.7
	Large	215	2.08	0.7
	Total	709	2.18	0.7
Preparing students for achievement tests***	Small	208	2.06	0.7
	Medium	291	2.00	0.8
	Large	213	1.75	0.8
	Total	712	1.94	0.8

*ANOVA, ***p-value < .001*

For six of the 22 PD topics evaluated, Pearson Correlations and two-tailed tests of significance indicated highly significant correlations (*p-value* > .001), with less-experienced teachers indicating they are more interested in attending PD on these topics compared to more experienced teachers (Table 35).

Table 35: Differences in Interest in STEM PD Topics by Years of Teaching Experience

PD Topics	Years of Experience	Responses	Mean	SD
Using real-world issues in the classroom ***	0–5 years	132	2.68	0.5
	6–10 years	160	2.68	0.5
	11–15 years	142	2.58	0.6
	16–20 years	126	2.59	0.6
	Over 20 Yrs.	165	2.42	0.6
	Total	725	2.59	0.6
Problem-based learning ***	0–5 years	131	2.69	0.5
	6–10 years	159	2.60	0.6
	11–15 years	137	2.55	0.6
	16–20 years	126	2.51	0.6
	Over 20 Yrs.	161	2.33	0.6
	Total	714	2.53	0.6
Instructional strategies for meeting the needs of diverse learners ***	0–5 years	132	2.48	0.6
	6–10 years	160	2.36	0.7
	11–15 years	141	2.26	0.7
	16–20 years	127	2.31	0.7
	Over 20 Yrs.	165	2.18	0.7
	Total	725	2.31	0.7
Integrating literacy practices with STEM learning ***	0–5 years	132	2.37	0.7
	6–10 years	159	2.23	0.7
	11–15 years	141	2.19	0.7
	16–20 years	127	2.17	0.7
	Over 20 Yrs.	164	1.99	0.7
	Total	723	2.18	0.7
Formative assessment for STEM learning ***	0–5 years	131	2.34	0.6
	6–10 years	160	2.20	0.7
	11–15 years	139	2.27	0.7
	16–20 years	126	2.16	0.7
	Over 20 Yrs.	164	1.98	0.7
	Total	720	2.18	0.7
Supporting classroom discourse ***	0–5 years	131	2.22	0.7
	6–10 years	156	2.04	0.7
	11–15 years	141	2.00	0.7
	16–20 years	125	1.90	0.6
	Over 20 Yrs.	161	1.80	0.7
	Total	714	1.99	0.7

*Pearson Correlation, ***p-value < .001*

A separate block of items on the survey asked teachers to indicate the perceived importance of, and level of interest in, an additional eight PD topics. As before, scaled mean scores were calculated for perceived importance of topic (1 = not important, 2 = slightly important, 3 = moderately important, 4 = very important) and level of interest in attending PD on that topic (1 = not interested, 2 = possibly interested, 3 = definitely interested).

Table 36 shows the mean perceived importance of, and mean interest in, the PD topics and is organized from highest mean to lowest mean score for importance of the topic. Plant sciences was perceived as the most important topic (mean = 2.3) followed by climate change (mean = 2.2) and local weather patterns (mean = 2.2). Of these eight PD topics, use of drones to collect scientific information (mean = 1.9) and bioinformatics (mean = 1.9) were perceived as the least important.

Respondents were the most interested in PD on robotics (mean = 1.8), climate change (mean = 1.8), and plant science (mean = 1.8).

Statistical analyses showed that there were significant differences in perceived importance of these topics and interest in attending PD on these topics based on the teachers' grade level, district size, and years of teaching experience. These significant differences or significant correlations are indicated with subscripts in Table 36. In the subsequent tables, the topics with significant or highly significant differences in level of interest between the subgroups are explored in greater detail.

There were also differences between responses from secondary science and secondary mathematics teachers; these differences are noted in Tables 40–42.

Regarding previous items on PD topics, the analysis between subgroups indicated that the rank order of items based on importance or interest depends on the grade level, school size, and years of teaching experience; therefore, it might be important to consider these different priorities when designing PD programs targeting particular teacher populations.

Table 36: Importance of, and Interest in, PD Topics

PD Topics	Importance			Interest		
	N	Mean	SD	N	Mean	SD
Plant sciences	745	2.30 a***	1.1	717	1.76 a***	0.8
Climate change	745	2.23	1.1	715	1.78	0.8
Local weather patterns	744	2.20 a***	1.1	720	1.74 a***	0.8
Robotics	742	2.10 b*	1.1	726	1.84 a*, b*	0.8
Coding/computer programming	746	2.06b**	1.1	723	1.75 b***	0.8
Soil health	743	2.03 a***	1.0	715	1.61 a**	0.7
Genetic engineering	742	1.96 a***	1.1	719	1.71 a***, c***	0.8
Use of drones to collect scientific data	741	1.91 a*	1.0	715	1.74 a***, c***	0.8
Bioinformatics	736	1.85 a**	1.0	711	1.58 a***	0.7

*a Significant differences based on grade level (ANOVA, * p-value < .05, **p-value < .01, ***p-value < .001)*
*b Significant differences based on district size (ANOVA, * p-value < .05, **p-value < .01, ***p-value < .001)*
*c Significant difference based on years of teaching experience (Pearson Correlation, ***p-value < .001)*

An ANOVA indicated that there were significant differences in the level of interest in attending PD related to seven of the nine topics based on the grade level taught. Elementary teachers reported a higher level of interest in attending PD related to local weather patterns, robotics, soil health, bioinformatics, and use of drones compared to secondary teachers (Table 37). Some of these differences might be explained by the curriculum content of elementary versus secondary teachers. For example, weather and soil are emphasized more in the elementary years than in secondary curriculum. However, many of these differences might reflect different levels of interest between secondary science and secondary math teachers. These potential differences are later explored in Table 40–42.

Table 37: Differences in Interest in Attending PD by Grade Level

PD Topics of More Interest to Elementary Teachers	Grade Level	Responses	Mean	SD
Local weather patterns***	Elementary	191	2.44	0.6
	Secondary	526	2.07	0.8
	Total	717	2.17	0.8
Robotics*	Elementary	189	2.44	0.7
	Secondary	525	2.05	0.8
	Total	714	2.15	0.8
Soil health**	Elementary	191	2.34	0.7
	Secondary	526	2.10	0.8
	Total	717	2.16	0.7
Bioinformatics***	Elementary	188	2.10	0.8
	Secondary	526	1.69	0.8
	Total	714	1.79	0.8
Use of drones to collect scientific data***	Elementary	187	2.06	0.8
	Secondary	524	1.81	0.8
	Total	711	1.88	0.8
PD Topics of More Interest to Secondary Teachers	**Grade Level**	**Responses**	**Mean**	**SD**
Plant sciences***	Elementary	190	2.45	0.6
	Secondary	528	2.64	0.5
	Total	718	2.59	0.6
Genetic engineering***	Elementary	191	1.73	0.7
	Secondary	521	2.03	0.7
	Total	712	1.95	0.7

*ANOVA, * p-value < .05, **p-value < .01, ***p-value < .001*

An ANOVA indicated that teachers from medium districts were significantly more interested in attending PD related to robotics (mean = 1.9) compared to teachers from large (mean = 1.8) or small districts (mean = 1.7) (Table 38). Additionally, teachers from small districts showed a lower level of interest in attending PD on coding/computer programming. Some of this may be attributed to the lower number of technology and engineering teachers in small districts (see Table 3).

Table 38: Differences in Interest in Attending PD by District Size

PD Topics	District Size	Responses	Mean	SD
Robotics*	Small	206	1.74	0.7
	Medium	293	1.94	0.8
	Large	214	1.81	0.8
	Total	713	1.84	0.8
Coding/computer programming***	Small	205	1.56	0.8
	Medium	291	1.82	0.8
	Large	214	1.85	0.8
	Total	710	1.75	0.8

*ANOVA, * p-value < .05, **p-value < .01, ***p-value < .001*

Pearson Correlations and 2-tailed t-tests showed negative and statistically significant correlations between years of teaching experience and interest in attending PD related to genetic engineering and the use of drones to collect scientific data (Table 39).

Table 39: Differences in Interest Attending PD by Years of Teaching Experience

PD Topics	Years of Experience	Responses	Mean	SD
Genetic engineering***	0–5 years	130	1.92	0.9
	6–10 years	157	1.82	0.9
	11–15 years	140	1.65	0.8
	16–20 years	125	1.65	0.8
	Over 20 Yrs.	164	1.53	0.7
	Total	716	1.71	0.8
Use of drones to collect scientific data***	0–5 years	130	1.90	0.8
	6–10 years	157	1.90	0.8
	11–15 years	141	1.70	0.8
	16–20 years	123	1.63	0.7
	Over 20 Yrs.	161	1.57	0.7
	Total	712	1.74	0.8

*Pearson Correlation, ***p-value < .001*

Significant Differences between Secondary Math and Science Teachers

After exploring the numerous significant differences in levels of interest based on grade level, district size, and years of experience for these PD topics, it was apparent that possible differences based on a teachers' subject area needed to be explored. However, because the MO-STEM PD

Needs Assessment permitted teachers to indicate all of the subjects they taught and the proportion of teaching for each subject, there were not clear divisions within subgroups based on subject, especially for elementary teachers. To address this issue, a subgroup of secondary science teachers (n = 244) and secondary mathematics teachers (n = 171) was identified in order to compare means related to their reported interest in attending PD related to all of the thirty topics combined. Equal variance within subgroups was assumed and t-tests were used to determine statistical significance.

The aggregate mean importance of PD topics (1 = not important, 2 = slightly important, 3 = moderately important, 4 = very important) and aggregate mean interest in PD topics was calculated (1 = not interested, 2 = possibly interested, and 3 = definitely interested) across all 30 PD topics on the survey. These overall means are reported in Table 40 and show, that of the respondents teaching grades 7–12, science teachers believe the PD topics are more important than do math teachers. In addition, science teachers were more interested in attending PD on these topics compared to secondary math teachers. Though these differences were small, they were statistically significant (*p-value* < .001 for importance, and *p-value* < .01 for interest), and suggest that the items on the needs assessment were viewed as more relevant to secondary science teachers than secondary math teachers by the respondents.

Table 40: Importance and Interest in PD Topics between Secondary Teachers

Aggregated Topics	Subject	Responses	Mean	SD
Importance of topics to teaching***	Math	167	2.75	0.5
	Science	235	2.93	0.5
Interest in attending PD on topics**	Math	164	1.99	0.4
	Science	228	2.12	0.4

*T-test, **p-value < .01, ***p-value < .001)*

The level of interest in attending PD on topics (1 = not interested, 2 = possibly interested, and 3 = definitely interested) was examined for secondary math and secondary science teachers. The PD topics with significant differences and a higher level of interest from math teachers are reported in Table 41. Compared to secondary science teachers, secondary math teachers were more interested in attending PD on CCSS for mathematics, mathematical practices, and also had a higher interest in PD on coding/computer programming.

Table 41: PD Topics of More Interest to Secondary Math Teachers

Professional Development Topics	Subject	Responses	Mean	SD
Common Core State Standards for Mathematics***	Math	160	2.17	0.7
	Science	226	1.42	0.6
Mathematical practices***	Math	160	2.68	0.5
	Science	226	1.67	0.7
Coding/computer programming***	Math	162	1.84	0.8
	Science	224	1.55	0.8

*T-test, **p-value < .01, ***p-value < .001)*

For many of the other topics listed on the STEM PD Needs Assessment, secondary science teachers were significantly more likely to indicate a higher level of interest in attending PD compared with secondary math teachers (Table 42).

Table 42: PD Topics of More Interest to Secondary Science Teachers

Professional Development Topics	Subject	Responses	Mean	SD
Using real-world issues in the classroom**	Math	161	2.58	0.6
	Science	226	2.72	0.5
Integrating authentic STEM research into the classroom***	Math	160	2.23	0.7
	Science	227	2.48	0.6
Next Generation Science Standards***	Math	157	1.39	0.6
	Science	226	2.18	0.7
Integrating literacy practices with STEM learning**	Math	161	1.97	0.7
	Science	227	2.21	0.7
Problem-based learning*	Math	156	2.46	0.6
	Science	225	2.61	0.6
Scientific practices (e.g., modeling and argumentation)***	Math	158	1.88	0.7
	Science	225	2.43	0.6
Inquiry-based laboratory activities***	Math	159	2.09	0.7
	Science	226	2.66	0.6
Genetic engineering***	Math	159	1.45	0.7
	Science	226	2.20	0.8
Climate change***	Math	158	1.44	0.7
	Science	223	2.12	0.8
Plant sciences***	Math	158	1.33	0.6
	Science	226	1.95	0.8
Bioinformatics***	Math	159	1.41	0.6
	Science	220	1.89	0.8
Soil health***	Math	157	1.34	0.6
	Science	224	1.74	0.8
Local weather patterns***	Math	160	1.51	0.7
	Science	224	1.83	0.8
Use of drones to collect scientific data***	Math	160	1.57	0.8
	Science	221	1.96	0.8

*T-test, *p-value <.05, **p-value < .01, ***p-value < .001*

Level of Internet Access

The last group of items on the survey asked teachers to rate how often five types of online access were available to them. Table 43 shows the distribution of responses in relationship to the size of the respondent's district. Percentages are reported within each district size. Forty-four percent of small districts report having no access to social media sites, whereas nearly the same percentage of teachers in large districts (40%) report always having access to these sites.

Table 43: Levels of Online Access in Respondent's School Building

Types of Online Access	Small District			Medium District			Large District			Total
	Never	Some-times	Always	Never	Some-times	Always	Never	Some-times	Always	
Reliable access to an internet connection at my school for email and web browsing	2 0.9%	29 13.6%	183 85.5%	1 0.3%	27 9.2%	265 90.4%	1 0.5%	13 6.1%	200 93.5%	721 100.0%
Reliable access to high speed internet at my school for viewing videos and streaming content	1 0.5%	76 35.8%	135 63.7%	1 0.3%	68 23.2%	224 76.5%	1 0.5%	42 19.6%	171 79.9%	719 100.0%
Access to online learning management systems (e.g., Blackboard, Moodle, and Global Classroom) at my school	29 16.2%	45 25.1%	105 58.7%	22 8.5%	65 25.0%	173 66.5%	9 4.7%	37 19.2%	147 76.2%	632 100.0%
Access to lesson portals (specialized websites with vetted collections of lesson plans, e.g., eThemes) at my school	22 13.7%	79 34.8%	142 51.6%	22 9.1%	79 32.5%	142 58.4%	17 10.2%	46 27.5%	104 62.3%	571 100.0%
Access to social media sites like Twitter and Facebook at my school	91 44.4%	61 29.8%	53 25.9%	101 36.6%	80 29.0%	95 34.4%	249 27.7%	207 32.0%	231 40.3%	687 100.0%

The responses were scored on a scale from 1 to 3 (1 = never available, 2 = sometimes available, 3 = always available). Mean scores were calculated for each of the five types of access. Table 44 shows the scaled mean scores from highest availability to lowest availability. Nearly 90% of respondents indicated that reliable access to an internet connection for email and web browsing was available at their school (mean = 2.9); however, only 34% of respondents always had access to social media sites like Twitter and Facebook (mean = 1.98).

Table 44: Levels of Online Access at School

Types of Online Access	N	Mean	SD
Reliable access to an internet connection at my school for email and web browsing*	735	2.89	0.3
Reliable access to high speed internet at my school for viewing videos and streaming content***	733	2.74	0.5
Access to online learning management systems (e.g., Blackboard, Moodle, and Global Classroom) at my school***	645	2.58	0.7
Access to lesson portals (specialized websites with vetted collections of lesson plans, e.g., eThemes) at my school	584	2.47	0.7
Access to social media sites like Twitter and Facebook at my school***	700	1.98	0.8

*ANOVA, * p-value < .05, **p-value < .01, ***p-value < .001*

Statistical tests comparing means across subgroups (i.e., grade level, district size, and years of teaching experience) showed only significant differences in teachers' reported levels of internet access by their district size. These differences are described in Table 45.

An ANOVA showed that respondents from medium and large districts had consistently higher levels of access to internet for email and web browsing, viewing videos and streaming content, accessing learning management systems, and accessing social media sites. Teachers from small districts were more likely to indicate limited access to internet for email and web browsing (mean = 2.85) and far less likely to have access to social media sites (mean = 1.81) compared to teachers from medium or small districts.

Table 45: Differences in Online Access by District Size

STEM PD Topics	District Size	Responses	Mean	SD
Reliable access to an internet connection at my school for email and web browsing*	Small	214	2.85	0.4
	Medium	293	2.90	0.3
	Large	214	2.93	0.3
	Total	721	2.89	0.3
Reliable access to high speed internet at my school for viewing videos and streaming content***	Small	212	2.63	0.5
	Medium	293	2.76	0.4
	Large	214	2.79	0.4
	Total	719	2.73	0.5
Access to online learning management systems (e.g., Blackboard, Moodle, and Global Classroom) at my school***	Small	179	2.42	0.8
	Medium	260	2.58	0.6
	Large	193	2.72	0.5
	Total	632	2.58	0.7
Access to social media sites like Twitter and Facebook at my school***	Small	205	1.81	0.8
	Medium	276	1.98	0.8
	Large	206	2.13	0.8
	Total	687	1.97	0.8

*ANOVA, * p-value < .05, **p-value < .01, ***p-value < .001)*

Summary

The purpose of this project was to determine the current professional development (PD) needs of educators teaching STEM topics throughout Missouri's schools. In spring 2016, a sample of Missouri's public school STEM teachers were surveyed and 16% (800) responded. Teachers represented small, medium, and large school districts and teachers at all levels of teaching experience. Their responses were analyzed and are reported by district size, elementary or secondary grade level, years of teaching experience, and in a few instances, teachers of only secondary math or science.

Nearly one-third of respondents reported participating in 21–40 hours of professional development during the past 12 months; however, little of that PD was in STEM areas. Secondary teachers reported a higher level of participation in STEM PD activities than did elementary teachers.

Respondents expressed interest in attending STEM professional development to improve instructional practices, believed that attending STEM PD would help improve their teaching, and indicated that STEM PD access can potentially benefit students in their school. Teachers at all levels reported it was very important to be able to access ready-to-use materials from PD programs and to be able to learn from other teachers.

When asked about their preferred modes of PD delivery and formats, respondents were most interested in one-time, half-day workshops or all-day workshops. Teachers indicated a higher level of interest in face-to-face PD formats compared to all online formats, preferring to attend programs offered at their school site or in their district or region.

Teacher were asked about 22 PD topic areas in order to assess their perceived importance of each topic and also their level of interest in attending PD about this topic. Responses varied by teachers' district size, grade level, and years of teaching experience. Overall, using real world issues in the classroom was perceived to be the most important area and had the highest level of interest. The second and third areas of both importance and interest were problem-based learning and use of educational technologies to support learning.

Teachers were asked about an additional nine topic areas regarding their perceived importance and interest in each topic. Plant sciences and climate change were reported to be of greatest importance; however, the most interest for PD activities was for robotics and climate change.

Nearly 90% of respondents indicated that reliable access to an internet connection for email and web browsing was available at their school; however, teachers from small districts were more likely to indicate limited access to internet for email and web browsing and far less likely to have access to social media sites compared to teachers from medium or small districts.

Appendix A: Teaching Assignments

Teachers were given four grade levels and four subject areas from which to select their current teaching assignment. Because they were asked to select all that applied, teachers may be included in more than one category. A subsequent question asked what proportion of his or her teaching was in each subject. Tables A-1, A-2, A-3, and A-4 report the combined results of these questions for each grade level.

To read the tables, note that the first line, e.g., *Math teaching assignment*, reports the respondent's answer to question 1. The *proportion of teaching* numbers show their responses to question 2. As in all surveys, responses between questions do not always exactly match.

On question one, 139 respondents reported teaching mathematics in grades K–3. On question two, 14 of these teachers reported all of their teaching assignment was in mathematics. There are contradictions in teacher responses, e.g., of the 139 respondents who are mathematics teachers, 11 report that all of their teaching is in science and three report all of their teaching is in engineering.

Although counts do not match exactly in some instances, these tables give a picture of the variety of STEM topics taught by respondents at each grade level range. The following tables show all responses, not individual respondents.

Table A-1: Proportion of Teaching for K–3 Teachers

Grades K–3 Teachers	Math	Science	Technology	Engineering
Math teaching assignment	***139***			
Proportion of teaching				
All of my teaching	14	11	5	3
More than half	9	3	3	2
About half	45	8	6	3
Less than half	68	109	64	9
Total	136	131	78	17
Science teaching assignment		***133***		
Proportion of teaching				
All of my teaching	12	11	5	3
More than half	9	3	3	2
About half	44	8	6	3
Less than half	65	108	64	9
Total	130	130	78	17
Technology teaching assignment			***75***	
Proportion of teaching				
All of my teaching	8	7	6	3
More than half	4	3	3	2
About half	25	6	6	3
Less than half	35	56	58	9
Total	72	72	73	17
Engineering teaching assignment				***21***
Proportion of teaching				
All of my teaching	5	5	5	3
More than half	2	2	1	2
About half	6	3	3	3
Less than half	7	10	11	9
Total	20	20	20	17

Table A-2: Proportion of Teaching for Grades 4–6 Teachers

Grades 4–6 Teachers	Math	Science	Technology	Engineering
Math teaching assignment	***71***			
Proportion of teaching				
All of my teaching	14	4	2	0
More than half	7	1	0	0
About half	16	7	3	1
Less than half	33	36	22	5
Total	70	48	27	6
Science teaching assignment		***62***		
Proportion of teaching				
All of my teaching	3	9	2	0
More than half	4	7	0	0
About half	14	10	4	1
Less than half	27	36	18	6
Total	48	62	24	7
Technology teaching assignment			***27***	
Proportion of teaching				
All of my teaching	2	2	4	0
More than half	3	2	0	0
About half	3	3	4	1
Less than half	14	16	19	7
Total	22	23	27	8
Engineering teaching assignment				***6***
Proportion of teaching				
All of my teaching	0	0	0	0
More than half	1	1	0	0
About half	0	0	2	1
Less than half	4	5	4	5
Total	5	6	6	6

Table A-3: Proportion of Teaching for Grades 7–8 Teachers

Grades 7–8 Teachers	Math	Science	Technology	Engineering
Math teaching assignment	***93***			
Proportion of teaching				
All of my teaching	61	5	1	1
More than half	11	4	1	1
About half	11	5	3	1
Less than half	6	6	9	9
Total	89	20	14	12
Science teaching assignment		***105***		
Proportion of teaching				
All of my teaching	1	73	1	1
More than half	3	20	1	1
About half	7	7	1	1
Less than half	11	5	20	16
Total	22	105	23	19
Technology teaching assignment			***20***	
Proportion of teaching				
All of my teaching	2	3	3	1
More than half	3	3	4	4
About half	3	2	3	3
Less than half	3	2	9	6
Total	11	10	19	14
Engineering teaching assignment				***18***
Proportion of teaching				
All of my teaching	1	2	1	4
More than half	3	3	2	3
About half	2	1	4	3
Less than half	4	2	4	8
Total	10	8	11	18

Table A-4: Proportion of Teaching for Grades 9–12 Teachers

Grades 9–12 Teachers	Math	Science	Technology	Engineering
Math teaching assignment	***161***			
Proportion of teaching				
All of my teaching	122	3	0	1
More than half	16	7	2	3
About half	8	4	5	6
Less than half	12	13	8	6
Total	158	27	15	16
Science teaching assignment		***215***		
Proportion of teaching				
All of my teaching	0	177	2	0
More than half	10	23	2	3
About half	7	6	2	5
Less than half	16	9	21	12
Total	33	215	27	20
Technology teaching assignment			***40***	
Proportion of teaching				
All of my teaching	0	3	6	1
More than half	2	7	10	8
About half	3	2	7	7
Less than half	4	2	15	10
Total	9	14	38	26
Engineering teaching assignment				***62***
Proportion of teaching				
All of my teaching	0	2	1	19
More than half	3	8	11	13
About half	7	5	6	15
Less than half	6	4	13	14
Total	16	19	31	61

Appendix B: Professional Development Hours

Table B-1: Hours of PD Participated in during the Past 12 months by District Size

Hours of PD	Small District	Medium District	Large District	Total Percent	Total Responses
0 hours	0.9%	0.3%	0.0%	0.4%	3
1–2 hours	3.5%	0.3%	0.4%	1.3%	10
3–5 hours	2.2%	4.7%	3.0%	3.4%	27
6–10 hours	10.9%	7.3%	8.1%	8.6%	67
11–20 hours	16.5%	11.0%	16.9%	14.4%	113
21–40 hours	31.7%	32.5%	28.8%	31.2%	244
41–60 hours	15.2%	22.7%	18.6%	19.3%	151
61–80 hours	8.7%	6.9%	5.9%	7.2%	56
More than 80 hours	10.4%	14.2%	18.2%	14.3%	112
Total	230 100.0%	317 100.0%	236 100.0%	783 100.0%	783

Table B-2: Hours of PD that Emphasized STEM Teaching or Learning by District Size

Hours of PD	Small District	Medium District	Large District	Total Percent	Total Responses
0 hours	33.9%	32.5%	19.6%	29.0%	227
1–2 hours	17.0%	12.3%	17.0%	15.1%	118
3–5 hours	16.1%	14.2%	14.0%	14.7%	115
6–10 hours	13.5%	12.9%	18.7%	14.8%	116
11–20 hours	9.1%	12.6%	8.9%	10.5%	82
21–40 hours	4.8%	6.6%	10.6%	7.3%	57
41–60 hours	3.5%	3.8%	6.0%	4.3%	34
61–80 hours	0.9%	1.9%	1.3%	1.4%	11
More than 80 hours	1.3%	3.2%	3.8%	2.8%	22
Total	230 100.0%	317 100.0%	235 100.0%	782 100.0%	782

Appendix C: Professional Development Topics

Teachers were shown a list of 22 teaching and learning topics and asked to report both 1.) their perceived importance of the topic, and 2.) their level of interest in participating in professional development in the topic area. For each area (i.e., importance and interest), PD topics are ranked by the calculated mean score (see Table 30) from highest to lowest score. For Table C-1, the highest score was ranked 1 and the lowest score was ranked 22. In the body of the report, tables are organized by "Importance," but this table is sorted by "Interest."

Table C-1: Importance of, and Interest in, PD Topics

Professional Development Topics	Ranking for Importance	Ranking for Interest
Using real-world issues in the classroom	1	1
Problem-based learning	2	2
Use of educational technologies to support learning	3	3
Integrating science, technology, engineering, and math	5	4
Strategies for student use of mobile technologies	9	5
Inquiry-based laboratory activities	7	6
Integrating authentic STEM research into the classroom	15	7
Instructional strategies for meeting the needs of diverse learners	4	8
Interdisciplinary STEM teaching	16	9
Formative assessment for STEM learning	14	10
Integrating literacy practices with STEM learning	10	11
Supporting girls and minorities in STEM	11	12
Mathematical practices	6	13
Aligning instruction and curriculum with standards	8	14
New Missouri learning standards	13	15
Scientific practices (e.g., modeling and argumentation)	12	16
Supporting classroom discourse	18	17
Engineering design practices	21	18
Analysis of "big data"	19	19
Preparing students for achievement tests	17	20
Next Generation Science Standards	20	21
Common Core State Standards for Mathematics	22	22

Appendix D: Additional Comments

At the end of the survey, respondents were asked to add any comments about their STEM professional development needs. Below are their verbatim comments by grade level and in alphabetical order.

Elementary Teachers

Medium-sized District

- I am no longer in the classroom, but my new position is the district (K-12) Instructional Technology Coach. I have answered to the best of my ability.
- I would love to attend STEM PDs to help me develop hands on & interesting lessons that help student engagement
- I've been looking for more information about how to get STEM started in my classroom, such as lesson plans, unit ideas, activities, etc. It all seems like fun time activities w/no information about what the students are to learn/figure out so I haven't done anything! Been looking for over a year, so either there's not enough info or I don't know what to look for.
- PD for early or primary K-2 that is free or low cost $25 & under or institutes that provide stipends STEAM
- Teach 1st grade, lot of stem concepts beyond students. believe in stem value & try to lay sturdy foundation for my students
- Technology is major deficiency! lack of access for students too! Internet reliability varies. District blocks lot of sites, not sure what is blocked & what is not. At times email is unreliable. Have reliable internet service at home. Have one computer for student use. Have requested IPADs but has not been granted as of today.
- We are not a hot district so using laptop & tablets is not always a accessible way to teach a lesson
- We aren't allowed to use social media in schools for obvious reasons, but the internet works if I was to use it.

Large-sized District

- PD would be great, provide it did not involve adding a "program". Everything is piled on & nothing is taken away. Too overwhelming. We teach an inch deep & a mile wide....

Secondary Teachers

Small-sized District

- Common core & NCLB have all but burned out many great teachers. Just let us teach. We have many certifications & degrees. Do those mean anything? Why keep hindering best teachers w/more work that takes away from student learning (curriculum)?
- I am near retirement. I have started PLTW Engineering at our school and we are fully accredited. I am not personally interested, but think this is a good idea

Medium-sized District

- Access to lesson portals are not provided by district but I use Buffalo Case Study.
- As long as there is so much emphasis from national and state government, along with local administrators on test scores, there is not enough time for any of this content or professional development.
- Baracud Blocks All I add STEM through Coding and Robotics during Constructive free time it isn't part of my Multimedia Curriculum! Our blogs are blocked by web filters.
- Biology engineering? I don't know what "big data" means.
- I am interested in learning about Modeling Instruction.
- I would like to see more hands-on, ready-to-use-in-classroom science trainings.
- It's not so much an issue of interest, usually my issue is w/the quality of the offerings. I've wasted too much time in my career in bad PD, not appropriate for my subj (phys/math) or my age grp (11-12). Seen too many life sciences elemtarty focused presentations! The best PD (hands down) I've attended is the "Modeling Method of Teaching Physics" Seminars & going to AP reading in my subjs. Physics subs hard to find.
- I'd like help adding NGSS to Chemistry curriculum while still increasing & incorporating STEM
- More STEM PD on non robotics topics. In this area I have never come across PD on anything except climate change, energy sources and robotics.
- Should be coded medium District is > 5000
- The issue is not professional development but PD geared to my area & getting my district to help me get there.
- We have a very strong STEM program in our after-school program, but not much is incorporated into the school day curriculum.

Large-sized District

- I am interested in STEM PD as long as it is not the normal "here's more technology just for the sake of using more technology in the classroom". Not ALL technology makes learning better. And please don't tell us that data shows that this works unless you actually have data to back up your claim.

- Pre Algebra and Algebra lessons using job based math. How do the subjects relate to real world careers. Show the kids the connection.

District size unknown

- I am Project Lead the Way certified to teach Design & modeling and Automation & Robotics
- I think there are several STEM opportunities out there, but other requirements, both building & district pull you away especially if you're a teacher of fewer than 15 years experience. Too many hurdles outside the discipline on teachers. The opportunities also used to be more prevalent during the summer rather than school year. Also many state standards in core curriculum are blocking flexibility for student & teachers to bring more STEM in classrooms.
- KC STEM Alliance provides a very supportive Framework for PD & enrichment for students & teachers in the KC area.