Evaluation of the Howard Hughes Science Grant Initiative, Year Three

Office of Shared Accountability

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Natalie Wolanin and Julie Wade, M.S.

Montgomery County Public Schools

OFFICE OF SHARED ACCOUNTABILITY

850 Hungerford Drive
Rockville, Maryland
301-279-3553

Dr. Jack R. Smith
Superintendent of Schools

Dr. Janet S. Wilson
Associate Superintendent

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Executive Summary for Howard Hughes Science Grant Initiative
Year Three: 2015−2016

Background and Evaluation Questions

The Office of Shared Accountability in Montgomery County Public Schools (MCPS) is conducting a multiyear evaluation of the implementation and outcomes of a science professional development (PD) initiative at the elementary school level. The implementation and evaluation of this three-year program (2013–2014 through 2015–2016) were supported by a grant from the Howard Hughes Medical Institute (HHMI). The evaluation was requested by the Office of Curriculum and Instructional Programs. This report documents the status of implementation of HHMI grant components during the third year of the initiative, provides feedback to relevant stakeholders for the program's improvement, and reports findings from a student outcome analysis. See reports for prior years of the grant (Wolanin and Wade, 2015a and 2015b).

The goal of the science PD initiative supported by HHMI was to train at least one staff member within each of the elementary schools in the district on targeted Next Generation Science Standards (NGSS) practices and skills. An additional goal of the HHMI grant project was to impact school science culture through these cohorts of trained elementary classroom teachers who can support science instruction in their schools as well as bring ideas to inspire science, technology, and engineering (STE) related school activities.

The objective of the third year (2015−2016) of the HHMI grant project was to continue to train a second cohort of elementary K–5 classroom teachers on targeted NGSS practices and skills. Three "just in time" professional development sessions were offered immediately prior to the start of each new marking period and focused on NGSS practices that best fit each grade's quarterly curriculum. The three sessions were an extension of the summer 2015 summer PD (year 2 of the grant), which addressed curriculum for marking period 1. A description of the summer PD and findings from the summer PD surveys can be found in a previous report (Wolanin and Wade, 2015b).

Guskey's (2000) model for evaluating PD was used as a framework for measuring the impact of the PD components of the HHMI grant. The five levels are:

- **Level 1: Participants' reactions**. Did they like it? Was it useful? Was the leader knowledgeable and helpful?
- **Level 2: Participants' learning**. Did participants acquire the intended knowledge and skills?
- **Level 3: Organization support and change**. Was implementation advocated, accommodated, facilitated, and supported?
- **Level 4: Participants' use of new knowledge and skills**. Did participants effectively apply the new knowledge and skills?
- **Level 5: Student learning outcomes**. What was the impact on students?

Summary of Methodology

K−5 teachers (N = 101) who participated in the summer 2015 PD and subsequent 2015−2016 school year PD comprised the sample for the evaluation.

To address what professional development activities were offered and their participation (evaluation question 1), documents obtained by program staff such as training records and materials, session agendas, and sign-in sheets were reviewed to determine the context of the PD and the extent to which it was implemented.

A follow-up survey was utilized to address aspects of the professional development which were important and useful to participants; how participants implemented and shared their new skills and knowledge; changes in participants' comfort level with teaching science and NGSS; changes in their school science culture and science instruction; and participants' reports of student engagement and achievement (evaluation questions 2−7). The follow-up survey was administered on-line during May–June 2016, after the last professional development was completed, to the teachers who participated in the 2015 summer PD and subsequent school-year PD. A total of 66 out of 101 participating K–5 teachers responded to the follow-up survey for a 65% response rate.

Data from surveys and document reviews were summarized using descriptive statistics. Quantitative data collected in the follow-up survey is reported descriptively; some survey data captured in both pre-training and in follow-up were analyzed with paired t-tests when sample sizes were sufficient. Qualitative data collected from open-ended survey questions were summarized and analyzed using categories of responses and frequency of those response categories; examples of illustrative responses also were presented.

To address the impact on Grade 5 students (question 8), a quasi-experimental design using a comparison group was used to examine student achievement in science. Students (n = 532) from Grade 5 2015−2016 classrooms in 17 schools whose teachers participated in any of the PD (cohort 1 or cohort 2) comprised the grant sample for outcome analysis. Students (n = 567) from Grade 5 2015−2016 classrooms in 17 similar schools (n = 567) whose teachers did not participate in any of the HHMI-supported science PD comprised the sample for the comparison group.

Science student achievement was measured with the 2016 Maryland School Assessment (MSA) in Science. Scale scores on the MSA Grade 5 Science exam were compared for the grant and comparison samples using an independent t-test. Further analysis used a nested ANOVA, with schools nested within groups. Finally, descriptive statistics, along with chi-square tests, were used to compare MSA proficiency levels between the two groups.

Summary of Key Findings

Question 1. What professional development activities were offered and what was the participation of the Cohort 2 teachers?

The 2015–2016 professional development included two days in summer 2015 plus three additional days during the 2015–2016 school year. The three additional days were “just in time” sessions designed to coincide with the upcoming marking period science curriculum. The PD sessions covered various NGSS practices and were customized to each grade level. There were a total of 101 cohort 2 participants and attendance ranged from 79–92 participants for each PD session.

Question 2. What aspects from the professional development did participants report as most important and useful? (Guskey’s Level 1 and 2)

The aspect found to be extremely useful by almost three-fourths of teachers was the scheduling of the professional development sessions right before each marking period. Learning about engineering design challenges (59%) and exploring science kits (55%) was found extremely useful by just over half; no respondents reported any aspect as “not useful at all”.

Question 3. How did participants report implementing and using the knowledge and skills they learned from the professional development during the 2015–2016 school year? (Guskey’s Level 4)

Overall, Cohort 2 teachers reported relatively high implementation of the eight NGSS practices into their science instruction. Nine out of 10 teachers reported incorporating Practice 1: Asking Questions and Defining Problems into ‘all’, ‘almost all’, or ‘often’. Approximately three fourths or more reported integrating five of the practices ‘all’, ‘almost all’ or ‘often’. There was some variability among grades, although none of the differences were statistically significant.

Question 4. How did participants share their new skills and knowledge with others? (Guskey’s Level 4)

Nine out of 10 of the teacher respondents reported that they shared their learned skills and knowledge at a grade level team meeting.

Question 5. How did the comfort level with teaching science and using the NGSS standards among participants compare with that reported before their participation?(Guskey’s Level 2)

The mean comfort level reported after the PD was statistically significantly higher than the comfort level reported in pre-PD survey responses for all eight practices. In the follow-up survey, more than three fourths of respondents reported they were very or extremely comfortable in incorporating five of the practices and more than two thirds reported that same level of comfort for the remaining three practices.

Question 6. How did participants describe their school science culture and science instruction after the PD compared with that reported before their participation? (Guskey’s Level 3)

<u>Science instruction</u>. Half of the Cohort 2 teachers reported that they greatly increased making connections between science and reading and writing, and their utilization of formative assessment probes; two fifths reported they greatly increased their use of science kits and the time they spent on science instruction. Finally, one third reported they greatly increased their use of technology

on science instruction. Although there were some differences among grade levels, they were not statistically significant.

In the follow-up survey, the teachers reported an average of 106 minutes spent weekly on science instruction; in the pre-training survey the teachers reported 93 minutes.   The difference was not statistically significant using a paired t-test.

<u>School science culture</u>. Using a 5-point rating scale, teachers were asked to rate various aspects of school culture on whether they hindered effective instruction up to promoted effective instruction. The mean rating for ‘parent expectation and involvement’ was higher (i.e., closer to promoted effective instruction) in the pre-survey than in the follow-up. ‘Time available for their own professional development’ had a higher mean rating in the follow-up survey (closer to promoted effective instruction) than in the pre-training survey. In order to measure how comfortable elementary teachers were with teaching science, especially compared math, Reading/Language Arts, and social studies, comfort level with the four subjects was assessed. Science had the lowest mean comfort level rating in the pre-training survey. When the comfort level was measured again in the follow-up survey, the mean comfort level rating for science was significantly higher in the follow-up survey compared with the pre-training survey, as was social studies.

In both the pre- and follow-up surveys, respondents from two thirds of the schools reported their school offered an after-school program for science or engineering enrichment in the corresponding school year, and respondents from more than half the schools reported there was a family science or engineering event. Respondents from a slightly higher percentage of schools in the follow-up survey reported that their school offered visits to science or engineering sites, participated in science fairs or events, sponsored meetings with science or engineering professionals, or hosted the American Association for the Advancement of Science (AAAS) volunteers.

Question 7. Did participants believe the knowledge and skills they acquired affected student engagement and achievement, and in what ways? (Guskey’s Level 5)

All teacher respondents reported that both student engagement and learning had increased greatly or somewhat as a result of the knowledge and skills the teachers learned through the professional development.

Question 8. Did Grade 5 students in classrooms of teachers who attended the HHMI funded professional development (either in 2014 or 2015) perform better on the Maryland School Assessment (MSA) Science than Grade 5 students in schools without participating teachers?(Guskey’s Level 5)

There was no difference in Grade 5 MSA Science scores or proficiency levels between students whose teacher participated in the HHMI grant and the comparison group. It should be noted that the MSA Science exam has not yet been updated to incorporate the integration of the NGSS standards, which was the primary focus of the grant’s professional development. This misalignment could contribute to findings of a lack of impact on student science achievement scores associated with the grant supported professional development.

Recommendations

- In order to transition elementary teachers to NGSS, adopted by the state of Maryland, and the approaching Maryland Integrated Science Assessment (MISA) assessment, which is aligned with NGSS, (MSDE, 2016a and 2016b), continue to offer K-5 professional development with the goals of increasing the understanding and implementation of all NGSS practices, and reaching more teachers and more schools. Additionally, continue to explore ways to increase the emphasis of science in schools and the availability of science and engineering resources to teachers.

- Encourage participating teachers to share what they have learned in PD beyond grade level teams, to extend the reach of the knowledge and skills learned about the NGSS practices.

Evaluation of the Howard Hughes Science Grant Initiative, Year Three

Natalie L. Wolanin and Julie H. Wade, M.S.

The Office of Shared Accountability (OSA) in Montgomery County Public Schools (MCPS) is conducting a multiyear evaluation of the implementation and outcomes of a science professional development (PD) initiative at the elementary school level. The implementation and evaluation of this three-year initiative (2013–2014 through 2015–2016) are supported by a grant from the Howard Hughes Medical Institute (HHMI). The evaluation was requested by the Office of Curriculum and Instructional Programs (OCIP). This report documents the status of implementation of HHMI grant components during the third year of the initiative and provides feedback to relevant stakeholders for the program's improvement, as well as provides findings from a student outcome analysis. See reports for prior years of the grant (Wolanin and Wade, 2015a and 2015b).

Background

The long-standing partnership of MCPS with HHMI has supported the district's vision for science instruction—that all students achieve full STEM literacy through standards referenced, problem/project based instruction that develops critical thinkers who apply scientific and engineering practices to non-routine problems in a globally competitive society (MCPS, 2015). Grants from HHMI have allowed teachers to have access to PD and experiences that otherwise would not be possible or would be greatly restricted due to fiscal limitations of the school district.

This report is the third in a series of reports addressing the implementation and outcomes of the three-year HHMI grant. The objective of the third year of the grant was to build the science content knowledge of elementary teachers and provide support for implementation of the updated elementary curriculum—Curriculum 2.0.

Concurrent with the implementation of Curriculum 2.0, Maryland adopted the *Next Generation Science Standards* (NGSS), released in April 2013, which specifically focuses on scientific literacy for all students. NGSS was developed by the National Research Council (NRC), The National Science Teachers Association (NSTA), the American Association for the Advancement of Science (AAAS), 26 state partners, and others (NGSS, 2016). To ensure the successful introduction of both Curriculum 2.0 and NGSS in MCPS, the Science, Technology, and Engineering (STE) office offered PD for teachers which was designed to emphasize student engagement with content and provide opportunities for students to apply their content knowledge within the context of real world problems. Learning components for the PD included training teacher leaders, development and delivery of a summer training institute, and ongoing support and coaching to ensure sustainable transfer of content and pedagogy. The NGSS scientific practices are:

- Practice 1: Asking Questions and Defining Problems
- Practice 2: Developing and Using Models
- Practice 3: Planning and Carrying Out Investigations

- Practice 4: Analyzing and Interpreting Data
- Practice 5: Use Mathematics and Computational Thinking
- Practice 6: Constructing Explanations and Designing Solutions
- Practice 7: Engaging in Argument from Evidence
- Practice 8: Obtaining, Evaluating, and Communicating Information

The goal of the HHMI supported science PD initiative was to train at least one staff member within each of the elementary schools in the district on targeted NGSS practices and skills. An additional goal of the HHMI grant project is to impact school science culture through these cohorts of trained elementary classroom teachers who can support science instruction in their schools as well as bring ideas to inspire STE-related school activities.

The objective of the third year (2015−2016) of the HHMI grant project was to continue to deliver knowledge and skills of targeted NGSS practices to a second cohort of elementary K–5 classroom teachers. The 2015–2016 professional development included two days in the summer of 2015 (year 2) plus three additional days during the 2015–2016 school year (year 3). The three additional days were “just in time” sessions designed to coincide with the upcoming marking period science curriculum. The summer 2015 PD addressed the curriculum for marking period 1. A description of the summer PD and findings from the summer PD surveys can be found in a previous report (Wolanin and Wade, 2015b).

Scope of the Study

Guskey’s (2000) model for evaluating PD is used as a framework for measuring the impact of the PD components of the HHMI grant. Guskey describes five sequential levels to be addressed in an evaluation of PD.

Level 1: Participants’ reactions. Did they like it? Was it useful? Was the leader knowledgeable and helpful?
Level 2: Participants’ learning. Did participants acquire the intended knowledge and skills?
Level 3: Organization support and change. Was implementation advocated, accommodated, facilitated, and supported?
Level 4: Participants’ use of new knowledge and skills. Did participants effectively apply the new knowledge and skills?
Level 5: Student learning outcomes. What was the impact on students?

The participants examined in the evaluation for Levels 1-4 were Cohort 2 elementary classroom teachers who attended the two day 2015 summer PD and/or subsequent PD sessions during the school year. The students examined for Level 5 were Grade 5 students’ science achievement whose teachers participated in cohort 1 or cohort 2 of the grant initiative A table displaying the five Guskey’s levels and corresponding evaluation questions and activities can be seen in Appendix A. This evaluation addresses the following questions:

1. What professional development activities were offered and what was the participation of the Cohort 2 teachers?

2. What aspects from the professional development did participants report as most important and useful? (Guskey's Level 1 and 2)

3. How did participants report implementing and using the knowledge and skills they learned from the professional development during the 2015–2016 school year? (Guskey's Level 4)

4. How did participants share their new skills and knowledge with others? (Guskey's Level 4)

5. How did the comfort level with teaching science and using the NGSS standards among participants compare with that reported before their participation? (Guskey's Level 2)

6. How did participants describe their school science culture and science instruction compared with that reported before their participation? (Guskey's Level 3)

7. Did participants believe the knowledge and skills they acquired affected student engagement and achievement, and in what ways? (Guskey's Level 5)

8. Did Grade 5 students in classrooms of teachers who attended the HHMI funded professional development (either in 2014 or 2015) perform better on the Maryland School Assessment (MSA) Science than Grade 5 students in schools without participating teachers? (Guskey's Level 5)

Methodology

The methodology contains two sections: 1) an implementation section, which covers evaluation questions 1-7, and 2) an outcome section, which covers evaluation question 8, followed by a strength and limitation section for the methodology of the total evaluation study.

Implementation

Design. A non-experimental design was used to answer evaluation questions 1-7.

Sample. K–5 classroom teachers (N = 101) who participated in the 2015 summer PD and subsequent 2015−2016 school year PD comprised the sample for the year 3 evaluation of the grant initiative.

Document Analysis. To address question 1, documents provided by program staff such as training records and materials, session agendas, and sign-in sheets were reviewed to determine the context of the PD and the extent to which it was implemented.

Follow-up survey. A follow-up survey of the Cohort 2 classroom teachers, who participated in the 2015 summer PD and subsequent school-year PD, was developed by OSA with input from program staff. The survey assessed teachers' perceptions of the usefulness of the PD and ways they have used the knowledge and skills gained; comfort level teaching science and the NGSS standards; perceived impact on student engagement and achievement; and their science instruction and school science culture. The follow-up survey was administered on-line during May–June 2016, after the last professional development was completed. A total of 66 of 101 K–5 teachers responded to the survey for a 65% response rate. Table 1 describes the survey respondents.

Table 1
Grade Level of Cohort 2 Follow-up Respondents

	Respondents (N = 66)	
Current Grade Level	*n*	%
Kindergarten	13	19.7
1st grade teacher	10	15.2
2nd grade teacher	12	18.2
3rd grade teacher	13	19.7
4th grade teacher	7	10.6
5th grade teacher	10	15.2
Other teacher	1	1.5

Analytical Methods. Data from surveys and document reviews were summarized using descriptive statistics. Quantitative data collected in the follow-up survey were reported descriptively; some survey data captured in both pre-training and in follow-up were analyzed with paired t-tests when sample sizes were sufficient. Qualitative data collected from open-ended survey questions were summarized and analyzed using categories of responses and frequency of those response categories; examples of illustrative responses also were presented.

Outcome

Design. To address question 8, a quasi-experimental design utilizing a comparison group was used to examine Grade 5 student achievement in science.

Sample. Students (n = 532) from Grade 5 2015−2016 classrooms in 17 schools - whose teachers participated in any of the PD (Cohort 1 or Cohort 2) comprised the grant sample for outcome analysis.

A comparison group was derived by randomly selecting students (n = 567) from Grade 5 2015−2016 classrooms in 17 schools that had no teachers participating in the HHMI PD. Schools at a Glance data were used to select comparison schools with similar demographic characteristics (i.e. race, English for Speakers of Other Languages [ESOL], Free and Reduced-price Meals System [FARMS], Special Education, and enrollment size). Classrooms of Grade 5 students were then randomly chosen from the comparison schools. Three of the schools had two Grade 5 teachers (i.e. two classes) who attended the PD; therefore, two classes were randomly chosen from their matched similar schools.

Science MSA Scores. Science student achievement scores were downloaded from MCPS student data files for the 2016 Maryland School Assessment (MSA) in Science. The Science MSA is administered each spring to all Grade 5 students. Proficiency levels (i.e. basic, proficient, and advanced) and scale scores were used for analysis.

Analytical Methods. Student achievement scale scores on the MSA Grade 5 Science exam for the grant and comparison samples were compared using an independent sample t-test. For further analysis, a nested ANOVA was utilized to account for schools nested within the grant or comparison group. Finally, descriptive statistics, along with chi-square, were used to compare proficiency levels (advanced, proficient, or basic) between the two groups.

Strengths and Limitations

The majority of cohort 2 participants responded to the online survey for a response rate of 65% and representing all grade levels. However, the number of responses resulted in small cell sizes when broken down by grade level, limiting analysis by grade level.

Teacher respondents self-reported their implementation of science instruction and the use of NGSS standards, and whether they thought student engagement and learning increased as a result of their participation in the professional development; therefore, there is a threat that response bias would likely lead to more positive results.

The MSA Science exam is administered to students in Grade 5 and not in prior grades. Further, there are no standardized science assessments administered prior to Grade 5; therefore, no pre-initiative measurement in science could be used as a control variable. Also, the MSA Science exam has not yet been updated to incorporate the integration of the NGSS standards, which was the primary focus of the grant's professional development. This misalignment could contribute to findings of a lack of impact on student science achievement scores associated with the grant supported professional development.

Findings

Question 1. What professional development activities were offered and what was the participation of the Cohort 2 teachers?

The 2015–2016 professional development included two days in the summer of 2015 plus three additional days during the 2015–2016 school year. The three additional days were "just in time" sessions meant to coincide with the upcoming marking period science curriculum.

The NGSS practices that were the focus at each of the PD sessions by grade level are shown in Table 2 below. Practice 5 and 8 were the only practices not covered by any session at any grade level. The NGSS scientific practices are:

- Practice 1: Asking Questions and Defining Problems
- Practice 2: Developing and Using Models
- Practice 3: Planning and Carrying Out Investigations
- Practice 4: Analyzing and Interpreting Data
- Practice 5: Use Mathematics and Computational Thinking
- Practice 6: Constructing Explanations and Designing Solutions
- Practice 7: Engaging in Argument from Evidence
- Practice 8: Obtaining, Evaluating, and Communicating Information

Table 2
Matrix of NGSS Practices in Professional Development Sessions by Grade Level

Grade level	Summer (MP1)	MP2	MP3	MP4	Total
K	Practice 1,7	Practice 3	Practice 2	Practice 6	Practice 1,2,3,6,7
1	Practice 1	Practice 3	Practice 2	Practice 4, 6	Practice 1,2,3,4,6
2	Practice 3	Practice 3	Practice 1, 2, 3	Practice 1, 2, 3, 6	Practice 1,2,3,6
3	Practice 3, 6	Practice 3,4	Practice 3, 4, 6	Practice 2, 3	Practice 2,3,4,6
4	Practice 2, 3	Practice 3	Practice 3,4	Practice 2	Practice 2,3,4
5	Practice 2	Practice 3,7	Practice 2, 3, 6	Practice 2	Practice 2,3,6,7

MP = marking period

Table 3 shows the attendance at each of the PD sessions by grade level and by total. Attendance ranged from 79-92 participants out of a total of 101 Cohort 2 participants. The session prior to Marking Period 3 had the lowest attendance for many of the grade levels.

Table 3
Matrix of PD Attendance by Grade Level (N = 101)

	Summer 2015 PD Attendance (MP1)		School year 2015-2016 PD Attendance		
Grade level	Day 1	Day 2	MP2	MP3	MP4
K	25	20	20	18	19
1	13	15	15	15	15
2	18	18	18	13	18
3	15	15	15	14	15
4	13	14	12	11	11
5	8	8	11	8	10
Total	92	90	91	79	88

MP = *marking period*

Question 2: What aspects from the professional development did participants report as most important and useful?

The aspects of the PD reported to be extremely useful by the majority of teachers was the scheduling of the professional development sessions (70%), followed by learning about engineering design challenges (59%) and exploring science kits (55%); conversely, 30% reported exploring the science kits as only somewhat useful (Table 4). No respondents reported any aspect of the PD as "not useful at all".

Table 4
Usefulness of PD Components among Cohort 2 Follow-up Respondents

		Extremely Useful		Very Useful		Somewhat Useful		Not Useful at All	
PD Aspects	*N*	*n*	%	*n*	%	*n*	%	*n*	%
The schedule of the PD's (i.e. one before each marking period)	66	46	69.7	17	25.8	3	4.5	0	0.0
Learning about engineering design challenges	66	39	59.1	23	34.8	4	6.1	0	0.0
Exploring MCPS science kits	64	35	54.7	10	15.6	19	29.7	0	0.0
Learning about assessment probes	66	31	47.0	28	42.4	7	10.6	0	0.0
Ways to incorporate science into reading and writing	65	30	46.2	30	46.2	5	7.7	0	0.0
Learning academic language	63	29	46.0	27	42.9	7	11.1	0	0.0
Learning about integrating technology	66	30	45.5	26	39.4	10	15.2	0	0.0
Learning about NGSS standards and how they apply to Curriculum 2.0	66	25	37.9	33	50.0	8	12.1	0	0.0

There was some variability among teachers in different grades regarding the usefulness of the professional development aspects; however, none were statistically significant (See Table B1, Appendix B). For example, a higher percent of Grade 3 teachers found learning about the NGSS standards extremely useful compared to the other grades; a higher percent of Grade 3 and 4 teachers found learning about engineering design challenges extremely useful; and a higher percent of Grade 4 teachers found learning about integrating technology extremely useful. A much lower percentage of kindergarten teachers rated learning academic language as extremely useful, and a lower percentage of Grade 1 teachers found exploring the science kits as extremely useful, but again, none of the differences were statistically significant.

Teachers also were asked if there was anything else that could have made the professional development more useful; teachers could provide more than one suggestion. Twenty-seven teachers provided a variety of suggestions: five responses pertained to the scheduling of the school year trainings; four responses suggested that materials, resources, electronic handouts and better science kits need to be provided: and another four indicated that they would like to see additional trainings added. Other suggestions (1 or 2) addressed the coverage of lessons at the trainings; to provide more hands-on activities; to provide clearer goals and vision; to share contact information; to incorporate more technology; to incorporate more question time and better file organization. Ten respondents reported that they could not think of anything to make the training better or they left only a positive comment. See Table B2 in Appendix B for the verbatim responses.

Question 3: How did participants report implementing and using the knowledge and skills they learned from the professional development during the 2015–2016 school year?

Respondents to the Cohort 2 survey reported the frequency of incorporating the practices in their lessons. It should be remembered that not all practices were covered in each grade, and practices 5 and 8 were not covered in this series of trainings, but the implementation of all eight practices was assessed in order to report a comprehensive picture of the incorporation of all NGSS practices. When asked how often they incorporated each practice into their science lessons, 9 out of 10 teachers chose 'all', 'almost all' or 'often' for incorporating Practice 1: Asking Questions and Defining Problems (Tables 5). Approximately three fourths or more (73% - 80%) reported integrating practice 2, 3, 4, 6 and 8 'all', 'almost all' or 'often'. Somewhat few respondents, just more than half (55%) reported integrating Practice 5 and 7, which is understandable given that these practices had little or no focus in the PD sessions across grades. Interestingly, Practice 8 had a high percentage of teachers reporting incorporation into their lessons despite that practice not being a focus in the PD. Tables 5a and 5b show some variability among grades. Grade 1 teachers, compared to the other grade levels, had the lowest percentage who reported they all/almost all/often incorporated practices into their teaching (with the exception of practice 1); less than 40% for five of the practices. However, none of the differences between grade levels were found to be statistically significant.

Table 5a
Frequency of Incorporating Practices 1 through 4 into Science Lessons among Cohort 2 Follow-up Respondents

			All/Almost All/Often		Sometimes		Rarely/ Never	
		N	*n*	%	*n*	%	*n*	%
Practice 1: Asking Questions and Defining Problems	Total	66	59	89.4	6	9.1	1	1.5
	Kindergarten^PD	13	12	92.3	1	7.7	0	0.0
	1st Grade^PD	10	9	90.0	1	10.0	0	0.0
	2nd Grade^PD	12	10	83.3	2	16.7	0	0.0
	3rd Grade	13	12	92.3	1	7.7	0	0.0
	4th Grade	7	6	85.7	1	14.3	0	0.0
	5th Grade	10	10	100.0	0	0.0	0	0.0
Practice 2: Developing and Using Models	Total	66	49	74.2	15	22.7	2	3.0
	Kindergarten^PD	13	10	76.9	2	15.4	1	7.7
	1st Grade^PD	10	5	50.0	5	50.0	0	0.0
	2nd Grade^PD	12	11	91.7	1	8.3	0	0.0
	3rd Grade^PD	13	10	76.9	3	23.1	0	0.0
	4th Grade^PD	7	6	85.7	1	14.3	0	0.0
	5th Grade^PD	10	7	70.0	3	30.0	0	0.0
Practice 3: Planning and Carrying Out Investigations	Total	65	51	78.5	13	20.0	1	1.5
	Kindergarten^PD	13	13	100.0	0	0.0	0	0.0
	1st Grade*	9	4	44.4	5	55.6	0	0.0
	2nd Grade^PD	12	10	83.3	2	16.7	0	0.0
	3rd Grade^PD	13	11	84.6	2	15.4	0	0.0
	4th Grade^PD	7	5	71.4	2	28.6	0	0.0
	5th Grade^PD	10	8	80.0	2	20.0	0	0.0
Practice 4: Analyzing and Interpreting Data	Total	66	48	72.7	15	22.7	3	4.5
	Kindergarten	13	10	76.9	3	23.1	0	0.0
	1st Grade^PD	10	4	40.0	5	50.0	1	10.0
	2nd Grade	12	9	75.0	3	25.0	0	0.0
	3rd Grade^PD	13	11	84.6	2	15.4	0	0.0
	4th Grade^PD	7	5	71.4	1	14.3	1	14.3
	5th Grade	10	9	9.0	1	10.0	0	0.0

Note. Grades with ^PD indicates the PD for that grade level covered the corresponding practice in at least one of the PD sessions**.**
Note. One teacher, not assigned to a grade level, was included in the Total row, but not grade level categories.

Table 5b
Frequency of Incorporating Practices 5 through 8 into Science Lessons among Cohort 2 Follow-up Respondents

			All/Almost All/Often		Sometimes		Rarely/ Never	
		N	*n*	%	*n*	%	*n*	%
Practice 5: Using Mathematics and Computational Thinking	Total	66	36	54.5	25	37.9	5	7.6
	Kindergarten	13	7	53.8	5	38.5	1	7.7
	1st Grade	10	4	40.0	5	50.0	1	10.0
	2nd Grade	12	6	50.0	6	50.0	0	0.0
	3rd Grade	13	9	69.2	3	23.1	1	7.7
	4th Grade	7	3	42.9	3	42.9	1	14.3
	5th Grade	10	7	70.0	3	30.0	0	0.0
Practice 6: Constructing Explanations and Designing Solutions	Total	66	53	80.3	12	18.2	1	1.5
	Kindergarten[PD]	13	10	76.9	3	23.1	0	0.0
	1st Grade[PD]	10	7	70.0	3	30.0	0	0.0
	2nd Grade[PD]	12	11	91.7	1	8.3	0	0.0
	3rd Grade[PD]	13	10	76.9	3	23.1	0	0.0
	4th Grade	7	6	85.7	1	14.3	0	0.0
	5th Grade[PD]	10	9	90.0	1	10.0	0	0.0
Practice 7: Engaging in Argument from Evidence	Total	66	36	54.5	24	36.4	6	9.1
	Kindergarten[PD]	13	8	61.5	4	30.8	1	7.7
	1st Grade	10	1	10.0	6	60.0	3	30.0
	2nd Grade	12	8	66.7	4	33.3	0	0.0
	3rd Grade	13	9	69.2	4	30.8	0	0.0
	4th Grade	7	5	71.4	1	14.3	1	14.3
	5th Grade[PD]	10	5	50.0	5	50.0	0	0.0
Practice 8: Obtaining, Evaluating, and Communicating Information	Total	65	48	73.8	15	23.1	2	3.1
	Kindergarten	13	9	69.2	4	30.8	0	0.0
	1st Grade	10	4	40.0	5	50.0	1	10.0
	2nd Grade	12	10	83.3	2	16.7	0	0.0
	3rd Grade	12	11	91.7	1	8.3	0	0.0
	4th Grade	7	6	85.7	1	14.3	0	0.0
	5th Grade	10	8	80.0	2	20.0	0	0.0

Note. Grades with [PD] indicates the PD for that grade level covered the corresponding practice in at least one of the PD sessions**.**
Note. One teacher, not assigned to a grade level, was included in the Total row, but not grade level categories.

Teachers were asked in the follow-up survey to give one or two examples of how they incorporated an NGSS practice into their science instruction. Examples of their responses are shown in Appendix C, Table C-1. Because integrating reading and writing into science was a focus of the professional development sessions, teachers were also asked to give an example of how they incorporated reading and writing into science. Table C-2 shows some examples of their responses.

Question 4. How did participants share their new skills and knowledge with others?

A vast majority (89%) of the teachers reported that they shared their learned skills and knowledge at a grade level team meeting (Table 6).

Table 6
Reported Ways Teachers Shared Professional Development
Skills and Knowledge with Others

	(*N* = 66)	
	n	%
Grade level meeting	59	89.4
Science or STEM Committee	7	10.6
Schoolwide staff meeting	4	6.1
No one	3	4.5
Other (SDT, teammates but not meeting, after school club, tweet, principal)	8	12.1

Note. Could choose more than one response, so percents add to more than 100.

Question 5: How did the comfort level with teaching science and using the NGSS standards among participants compare with that reported before their participation?

Teachers were asked in the follow-up survey to rate their level of comfort incorporating each of the NGSS practices. Comfort was rated on a 5-point scale: 1=not at all comfortable, 2=slightly comfortable, 3=somewhat comfortable, 4=very comfortable, 5=extremely comfortable. The majority of teachers gave a rating of very comfortable or extremely comfortable for each practice (Table 7). Across all grades, more than three fourths (76%−82%) rated Practices 1, 2, 3, 6, and 8 very or extremely comfortable to incorporate and 65%−71% gave this rating for Practices 4, 5 and 7.

Table 7
Comfort Level of Incorporating Practices into Science Lessons among Cohort 2 Follow-up Respondents

			Extremely/ Very Comfortable		Somewhat Comfortable		Slightly/Not at All Comfortable	
		N	*n*	%	*n*	%	*n*	%
Practice 1: Asking Questions and Defining Problems	Total	66	54	81.8	12	18.2	0	0.0
	Kindergarten^{PD}	13	10	76.9	3	23.1	0	0.0
	1st Grade^{PD}	10	8	80.0	2	20.0	0	0.0
	2nd Grade^{PD}	12	9	75.0	3	25.0	0	0.0
	3rd Grade	13	10	76.9	3	23.1	0	0.0
	4th Grade	7	6	85.7	1	14.3	0	0.0
	5th Grade	10	10	100.0	0	0.0	0	0.0
Practice 2: Developing and Using Models	Total	66	50	75.8	15	22.7	1	1.5
	Kindergarten^{PD}	13	10	76.9	2	15.4	1	7.7
	1st Grade^{PD}	10	8	80.0	2	20.0	0	0.0
	2nd Grade^{PD}	12	7	58.3	5	41.7	0	0.0
	3rd Grade^{PD}	13	9	69.2	4	30.8	0	0.0
	4th Grade^{PD}	7	6	85.7	1	14.3	0	0.0
	5th Grade^{PD}	10	9	90.0	1	10.0	0	0.0
Practice 3: Planning and Carrying Out Investigations	Total	66	53	80.3	13	19.7	0	0.0
	Kindergarten^{PD}	13	11	84.6	2	15.4	0	0.0
	1st Grade^{PD}	10	7	70.0	3	30.0	0	0.0
	2nd Grade^{PD}	12	10	83.3	2	16.7	0	0.0
	3rd Grade^{PD}	13	10	76.9	3	23.1	0	0.0
	4th Grade^{PD}	7	4	57.1	3	42.9	0	0.0
	5th Grade^{PD}	10	10	100.0	0	0.0	0	0.0
Practice 4: Analyzing and Interpreting Data	Total	66	47	71.2	18	27.3	1	1.5
	Kindergarten	13	10	76.9	3	23.1	0	0.0
	1st Grade^{PD}	10	4	40.0	5	50.0	1	10.0
	2nd Grade	12	9	75.0	3	25.0	0	0.0
	3rd Grade^{PD}	13	10	76.9	3	23.1	0	0.0
	4th Grade^{PD}	7	5	71.4	2	28.6	0	0.0
	5th Grade	10	8	80.0	2	20.0	0	0.0

Table 7, continued

			Extremely/ Very Comfortable		Somewhat Comfortable		Slightly/Not at All Comfortable	
		N	*n*	%	*n*	%	*n*	%
Practice 5: Use Mathematics and Computational Thinking	Total	65	45	69.2	20	30.8	0	0.0
	Kindergarten	13	9	69.2	4	30.8	0	0.0
	1st Grade	10	6	60.0	4	40.0	0	0.0
	2nd Grade	11	7	63.6	4	36.4	0	0.0
	3rd Grade	13	10	76.9	3	23.1	0	0.0
	4th Grade	7	4	57.1	3	42.9	0	0.0
	5th Grade	10	8	80.0	2	20.0	0	0.0
Practice 6: Constructing Explanations and Designing Solutions	Total	66	51	77.3	15	22.7	0	0.0
	Kindergarten PD	13	11	84.6	2	15.4	0	0.0
	1st Grade PD	10	5	50.0	5	50.0	0	0.0
	2nd Grade PD	12	11	91.7	1	8.3	0	0.0
	3rd Grade PD	13	9	69.2	4	30.8	0	0.0
	4th Grade	7	4	57.1	3	42.9	0	0.0
	5th Grade PD	10	10	100.0	0	0.0	0	0.0
Practice 7: Engaging in Argument from Evidence	Total	65	42	64.6	22	33.8	1	1.5
	Kindergarten PD	12	7	58.3	5	41.7	0	0.0
	1st Grade	10	5	50.0	4	40.0	1	10.0
	2nd Grade	12	9	75.0	3	25.0	0	0.0
	3rd Grade	13	9	69.2	4	30.8	0	0.0
	4th Grade	7	5	71.4	2	28.6	0	0.0
	5th Grade PD	10	6	60.0	4	40.0	0	0.0
Practice 8: Obtaining, Evaluating, and Communicating Information	Total	66	51	77.3	14	21.2	1	1.5
	Kindergarten	13	11	84.6	2	15.4	0	0.0
	1st Grade	10	6	60.0	4	40.0	0	0.0
	2nd Grade	12	10	83.3	2	16.7	0	0.0
	3rd Grade	13	8	61.5	5	38.5	0	0.0
	4th Grade	7	6	85.7	1	14.3	0	0.0
	5th Grade	10	9	90.0	1	10.0	0	0.0

Note. Grades with PD indicates the PD for that grade level covered the corresponding practice in at least one of the PD sessions.
Note. One teacher, not assigned to a grade level, was included in the Total row, but not grade level categories.

Teachers also were asked to rate their comfort level with the eight practices in the pre-training survey which was administered prior to the two-day initial summer training. Using a paired t-test, mean ratings from the pre-training survey to the follow-up survey were compared (Table 8); only teachers who took both surveys were included. For each of the eight practices, there was a statistically significant increase in comfort level reported after the PD compared to pre-PD survey responses ($p < .001$).

Table 8
NGSS Practice Comfort Level Reported by Cohort 2 Respondents:
Pre- and Follow-up Surveys

		Pre-training Survey		Follow-up Survey				
	N	Mean	SD	Mean	SD	Mean difference	t	p
P1: Asking Questions and Defining Problems	57	2.07	1.15	4.05	0.69	1.98***	12.01	.000
P2: Developing and Using Models	57	1.93	1.10	3.98	0.74	2.05***	12.59	.000
P3:Planning and Carrying Out Investigation	57	2.00	1.13	4.12	0.76	2.12***	11.87	.000
P4: Analyzing and Interpreting Data	56	1.91	1.07	3.82	0.74	1.91***	11.82	.000
P5: Using Mathematics and Computational Thinking	56	1.80	1.03	3.84	0.73	2.04***	13.14	.000
P6: Constructing Explanations and Designing Solutions	57	1.70	1.03	3.88	0.63	2.18***	16.39	.000
P7: Engaging in Argument from Evidence	56	1.71	1.00	3.79	0.73	2.07***	15.69	.000
P8: Obtaining, Evaluating, and Communicating Information	57	1.88	1.15	3.84	0.65	1.97***	12.58	.000

*** $p<.001$

Note. Comfort was rated in a 5-point scale: 1=not at all comfortable, 2=slightly comfortable, 3=somewhat comfortable, 4=very comfortable, 5=extremely comfortable

Question 6: How did participants describe their school science culture and science instruction compared with that reported before their participation?

Teachers reported whether various changes occurred in their science instruction compared to before their participation in the professional development (Table 9). Half reported that they greatly increased their connecting science with reading and writing and greatly increased their utilization of formative assessment probes; 42%–43% reported they greatly increased their use of science kits and the time they spent on science instruction. Finally, one third reported they greatly increased their use of technology on science instruction.

Table 9
Extent of Change Among Cohort 2 Follow-up Respondents

		Greatly Increased		Somewhat Increased		No Change/ Decreased	
Changes	*N*	*n*	*%*	*n*	*%*	*n*	*%*
Connect science with reading and writing	65	33	50.8	25	38.5	7	10.8
Utilize formative assessment probes	65	32	49.2	30	46.2	3	4.6
Use MCPS science kits	65	28	43.1	24	36.9	13	20.0
Spend time on science instruction	65	27	41.5	30	46.2	8	12.3
Use technology in science instruction	65	22	33.8	36	55.4	7	10.8

Note. There were no "Not useful at all" ratings

A breakdown by grade can be seen in Appendix D. Some of the notable differences were:

- Compared to the other grades, a higher percentage of Grade 5 teachers reported greatly increasing their use of technology in science instruction (60% vs. 15%−43%).
- 82% of Grade 2 teachers reported greatly increasing their use of formative assessment probes (vs. 15%−71% among the other grade levels).
- None of the Grade 1 teachers greatly increased their use of science kits
- 85% of kindergarten teachers greatly increased their use of connecting science with reading and writing (vs. 39%−57%).

However, cell counts were small and none of the differences between grade levels were statistically significant.

Teachers were asked in the follow-up survey, to estimate their average weekly time spent on science instruction. Overall, the reported mean time per week was 109 minutes and the reported median time was 90 minutes per week (Table 10). The lowest average time spent was 90 and 91 minutes among Grade 1 and Grade 5 teachers, with a minimum time of 45 and 30 minutes, respectively. The highest average time spent was among 4th grade teachers (mean = 141 minutes) with a reported minimum of 60 minutes weekly. However, none of the differences among grade levels were statistically significant.

Table 10
Average Weekly Time on Science Instruction Reported by
Cohort 2 Follow-up Respondents

	N	*Mean*	*S.D.*	*Median*	*Min*	*Max*
Total	63	108.7	51.5	90.0	30	250
Kindergarten	12	112.9	70.1	87.5	45	250
1st Grade	10	89.5	37.2	90.0	45	180
2nd Grade	12	110.8	39.7	120.0	60	200
3rd Grade	13	112.7	45.1	120.0	60	180
4th Grade	7	141.4	54.3	120.0	60	220
5th Grade	9	90.6	54.7	90.0	30	180

Using a paired t-test, the reported average weekly time on science instruction was compared from the pre-training survey to the follow-up survey; only teachers who gave a response in both surveys were included. Although the mean time reported in the follow-up survey was higher than in the pre-training survey (106 minutes vs. 93 minutes), the difference was not statistically significant (Table 11).

Table 11
Average Weekly Minutes of Science Instruction Reported
by Cohort 2 Respondents: Pre-PD and Follow-up

Science Instructional Time	Pre Survey (*N* = 53) Mean	Pre Survey (*N* = 53) SD	Follow-up Survey (*N* = 53) Mean	Follow-up Survey (*N* = 53) SD	Mean difference	t	p
Average weekly minutes taught science	92.7	39.7	106.3	51.9	13.7	1.77	.083

Using a 5-point rating scale, teachers were asked to rate various aspects of school culture on whether they hindered effective instruction (rated a '1') up to promoted effective instruction (rated a '5'). A paired t-test was used to compare mean ratings from the pre-training survey to the follow-up survey. As shown in Table 12, the rating for parent expectation and involvement was higher (closer to promoted effective instruction) in the pre-survey than in the follow-up (3.47 vs. 2.73). Time available for their own professional development had a higher mean rating in the follow-up survey (closer to promoted effective instruction) than in the pre-training survey (3.46 vs. 2.68).

Table 12
School Science Culture Reported by Cohort 1 Respondents: Pre- and Follow-up

	N	Pre-training Survey Mean	Pre-training Survey SD	Follow-up Survey Mean	Follow-up Survey SD	Mean difference	t	p
Parent expectation and involvement	55	3.47	1.12	2.73	1.28	-.74**	-3.08	.003
Administration support that was provided	55	3.71	2.70	3.16	1.27	-.55	-1.47	.147
Time available to plan individually or with colleagues	56	2.98	1.31	3.18	1.38	.20	.834	.409
Time available for your own PD	56	2.68	1.41	3.46	1.39	.78***	3.37	.001
Importance that your school places on science	56	3.13	1.21	3.04	1.25	-.09	-.437	.664
Contents of materials in science kits	56	3.25	1.38	3.25	1.31	.00	.000	1.000
Availability of other science resources	54	2.72	1.57	2.94	1.27	.22	1.088	.281

SD = standard deviation
*p < .05, **p<.01, ***p<.001
Note. Scale 1 to 5 was used where 1 = Hindered Effective Instruction and 5 = Promoted Effective Instruction.

In order to measure how comfortable elementary teachers were with teaching science, especially compared to the other three core subjects (math, Reading/Language Arts, and social studies) they teach, teachers were asked in the pre-survey to rate their comfort level for all four subjects using a 5-point scale where 1 = not at all comfortable and 5 = extremely comfortable. As shown in Table 13, science had the lowest mean comfort level rating in the pre-training survey (mean = 3.81). The mean comfort level rating was measured again in the follow-up survey, after teachers participated in the science PD sessions. The mean comfort level rating for science was significantly higher in the follow-up survey (4.42 vs. 3.61) as was social studies (4.11 vs. 3.81).

Table 13
Subject Area Comfort Level Reported by Cohort 1 Respondents: Pre- and Follow-up

		Pre-training Survey		Follow-up Survey				
	N	Mean	SD	Mean	SD	Mean difference	t	p
Mathematics	57	4.46	.657	4.54	.657	.088	1.000	.322
Science	57	3.61	.940	4.42	.565	.807***	7.131	.000
Reading/Language Arts	57	4.25	.763	4.32	.827	.07	.753	.455
Social Studies	57	3.81	.833	4.11	.838	.298*	2.602	.012

Note. Scale from 1 to 5 was used where 1 = Not at all comfortable and 5 = Extremely comfortable
*$p < .05$, **$p<.01$, ***$p < .001$*

Teachers were asked if their school participated in various science or engineering activities during the 2015−2016 school year (follow-up survey) and the 2014−2015 year (pre-training survey). Only one response was counted per school; school-level responses are shown in Table 14. According to responses to the pre-survey, during 2014-2015, two thirds of schools offered after school programs for science or engineering enrichment, more than one half (57%) of schools held a family science or engineering event, and four out of ten offered one or more science and/or engineering clubs. The percentage of schools offering these three activities did not change after training, according to responses to the follow-up survey. The percentage of schools offering the remaining four activities during the school year did increase slightly after the training, based on responses to the pre-survey compared to those on the follow-up surveys.

Table 14
School Participation in STEM Activities Reported by Cohort 2
School-Level Responses

	Pre-Survey			Follow-up		
STEM activity	N	n	%	N	n	%
Offer after school programs for science and/or engineering enrichment.	40	26	65.0	44	29	65.9
Hold family science and/or engineering nights/events.	40	23	57.5	44	25	56.8
Visit to science/engineering sites.	40	12	30.0	47	20	42.6
Offer one or more science and/or engineering clubs.	40	17	42.5	45	19	42.2
Participated in local or regional science or engineering fair/event.	40	9	22.5	45	15	33.3
Sponsors meeting with science or engineering professionals.	40	3	7.5	34	8	23.5
Host AAAS volunteers in your science classrooms.	40	3	7.5	44	8	18.2

Note. Only 1 response is reported per school. If one respondent indicated the school offered or was planning to offer an activity, it is reported.
Note. The survey question formats differed between the pre-survey (a non-mutually exclusive multiple choice question) and follow-up survey (a yes/no response for each item.)

Question 7: Did participants believe the knowledge and skills they acquired affected student engagement and achievement and in what ways?

Using a 3-point scale, teachers were asked to rate whether student engagement or student learning had greatly increased, somewhat increased, or not increased, as a result of the knowledge and skills they (i.e., teachers) learned through the professional development. All respondents reported that both student engagement and learning had increased; more than half reported student engagement greatly increased (63%) and that student learning greatly increased (57%) as seen in Table 15.

Table 15
Extent of Change in Student Engagement and Learning Reported by
Cohort 2 Follow-up Respondents

		Greatly Increased		Somewhat Increased		Not Increased	
Changes	*N*	*n*	%	*n*	%	*n*	%
Student engagement	64	40	62.5	24	37.5	0	0.0
Student learning	65	37	56.9	28	43.1	0	0.0

Question 8: Did Grade 5 students in classrooms of teachers who attended the HHMI funded professional development (either in 2014 or 2015) perform better on the Maryland School Assessment (MSA) Science than Grade 5 students in schools without participating teachers?

Table 16 shows demographics characteristics of the Grade 5 students in the grant group compared to the students in the comparison group. For the most part, the two groups were very similar in terms of gender, race/ethnicity and services received. The grant group had a slightly lower percent of Hispanic/Latino students than the comparison group (23% vs. 28%) and a slightly higher percent of White students than the comparison groups (27% vs. 20%).

Table 16
Characteristics of Grade 5 Students in the Grant and Comparison Groups

	Grant *N* = 532		Comparison *N* = 567	
Characteristics	*n*	%	*n*	%
Gender				
Female	262	49.2	286	50.4
Male	270	50.8	281	49.6
Race/ethnicity				
Asian	126	23.7	125	22.0
Black or African American	114	21.4	149	26.3
Hispanic/Latino	124	23.3	160	28.2
White	143	26.9	111	19.6
Multiple	24	4.5	22	3.9
Services				
Current FARMS	225	39.7	209	39.3
Current Special Education	53	10.0	70	12.3
Current ESOL	57	10.1	33	6.2

Note. American Indian category is not shown due to low sample size.

Half of the students in the grant group and half of the students in the comparison group scored at the proficiency level for the MSA science exam and 40% scored at the basic level (Table 17). The slight differences between the two groups was not statistically significant: $\chi^2(2, N = 1{,}099) = .017, p > .05$

Table 17
Proficiency Level of Grade 5 MSA Science Scores Among Students in the Grant and Comparison Groups

	Grant N = 532		Comparison N = 567	
Characteristics	*n*	%	*n*	%
Basic	210	39.5	226	39.9
Proficient	269	50.6	285	50.3
Advanced	53	10.0	56	9.9

$^*p < .05$, $^{**}p < .01$, $^{***}p < .001$.

Using an independent t-test, mean MSA Science exam scale scores from the grant group and comparison groups were compared (Table 18). The scores were very close; the difference was not statistically significant ($t(1093) = .194$, $p > .05$).

Table 18
Mean Level and Standard Deviation of Grade 5 MSA Science Scale Score by Grant and Comparison Groups

	Grant			Comparison				
	N	Mean	Standard deviation	*N*	Mean	Standard deviation	*t*	df
MSA Science	532	403.25	49.70	567	403.83	49.76	.194	1092.7

$^*p < .05$, $^{**}p < .01$, $^{***}p < .001$.

Further analysis using nested ANOVA, which took into account that the schools were nested within the grant and comparison groups, also did not find any statistically significant differences between the two groups: $F(1, 40.8) = .443$, $p = .51$).

MSA scores among students from the grant group whose teachers were in cohort 1 were compared to students whose teachers were in cohort 2. Among the Grade 5 students in the grant group, 44% were from classrooms with Cohort 1 teachers and 56% were from classrooms with Cohort 2 teachers. Cohort 1 teachers participated in the four day summer 2014 PD and cohort 2 teachers participated in the two-day summer 2015 PD plus three sessions during the 2015–2106 school year. The difference in mean MSA scores between groups were not statistically significant, ($t(530) = .017$, $p > .05$). (Table 19).

Table 19
Mean Level and Standard Deviation of Grade 5 MSA Science Scale Score for Students with Cohort 1 and Cohort 2 Teachers

	Cohort 1			Cohort 2				
	N	Mean	Standard deviation	*N*	Mean	Standard deviation	*t*	df
MSA Science	232	403.2	48.20	300	403.28	50.90	.017	530

**p* < .05, ***p* < .01, ****p* < .001.

Summary

Most Cohort 2 teachers found the new schedule of professional development (i.e. a "just in time" session before each marking period) extremely useful and most found learning about engineering design useful. Although most found learning about the science kits useful, one third found that it was only somewhat useful. Overall, cohort 2 teachers reported relatively high implementation of the NGSS practices into their science instruction and most stated that they shared their new knowledge with their grade level team. Three fourths or more of the participants reported they were very or extremely comfortable with the use of most of the NGSS practices. The lowest comfort level was for Practice 5: Using Mathematics and Computational Thinking, and Practice 7: Engaging in Argument from Evidence. The comfort level increased at a statistically significant level for all eight practices when compared to the participants' comfort level prior to professional development; much of the increase occurred immediately after the summer training.

Half of the participants reported that they greatly increased connecting science with reading and writing and utilizing assessment probes. Furthermore, based on pre-training and follow-up survey findings, there was some evidence of an increase in time spent on science instruction (although differences were not statistically significant.) Cohort 2 teachers also reported an increase in school science and engineering activities and thought student engagement and student learning had increased among their students since their professional development.

There was no evidence that professional development efforts increased student achievement on the Grade 5 Science MSA. However this effort is still early in its implementation, and the MSA Science exam has not been adjusted to incorporate integration of the newly created NGSS practices. In March 2017, the Maryland Integrated Science Assessment (MISA), which will be aligned to NGSS, will replace the Science MSA.

Recommendations

- In order to transition elementary teachers to NGSS, adopted by the state of Maryland, and the approaching MISA assessment, which is aligned with NGSS, (MSDE, 2016a and 2016b), continue to offer K-5 professional development with the goals of increasing the understanding and implementation of all NGSS practices, and reaching more teachers and more schools. Additionally, continue to explore ways to increase the emphasis of science in schools and the availability of science and engineering resources to teachers.

- Encourage participating teachers to share what they have learned in PD beyond grade level teams, to extend the reach of the knowledge and skills learned about the NGSS practices.

References

Guskey, R.R. (2000). *Evaluating professional development*. Thousand Oaks, California: Corwin Press.

Maryland State Department of Education. (2016a) School Improvement in Maryland. Teaching and Learning: Science. http://mdk12.msde.maryland.gov/instruction/curriculum/science/index.html

Maryland State Department of Education (2016b). Memo to Members of the State Board of Education, January 26, 2016. http://archives.marylandpublicschools.org/stateboard/boardagenda/02122016/TabG1-G6-MDScienceProgramESSAAmendment.pdf

MCPS. (2015). Science, Technology, and Engineering. Retrieved from http://www.montgomeryschoolsmd.org/curriculum/science/.

Next Generation Science Standards (2016). Development Overview (NGSS). Retrieved July 9, 2016, from http://www.nextgenscience.org/development-process

Wolanin, N. & Wade, J. (2015a). *Evaluation of the Howard Hughes Science Grant Project, Year One*. Rockville, MD: Montgomery County Public Schools.

Wolanin, N. & Wade, J. (2015b). *Evaluation of the Howard Hughes Science Grant Initiative, Year Two*. Rockville, MD: Montgomery County Public Schools.

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Appendix A

Guskey's Model with Evaluation Questions

Table A-1
Evaluation Activities Using Guskey's Model for Evaluating Professional Development

Level of evaluation	Instrument/activity	Evaluation Question
1. Participants' reactions	Follow-up surveys of Cohort 2 teachers	Q2 What aspects from the professional development do participants report as most important and useful?
2. Participants' learning	Follow-up surveys of Cohort 2 teachers	Q2 What aspects from the professional development do participants report as most important and useful? Q5 How does the comfort level with teaching science and using the NGSS standards among participants compare with that reported before their participation?
3. Organization support and change	Follow-up surveys of Cohort 2 teachers	Q6 How do participants describe their school science culture and science instruction compared with that reported before their participation?
4. Participants' use of new knowledge and skills	Follow-up surveys of Cohort 2 teachers	Q3 How do participants report implementing and using the knowledge and skills they've learned from the professional development during the 2015-2016 school year? Q4 How do participants share their new skills and knowledge with others?
5. Student learning outcomes	Follow-up surveys of Cohort 2 teachers and Grade 5 Science MSA Student Scores	Q7 Do participants believe the knowledge and skills they've acquired has affected student engagement and achievement, and in what ways? Q8 Do Grade 5 students in classrooms of teachers who attended the HHMI funded professional development perform better on the Maryland School Assessment (MSA) Science than Grade 5 students in schools without participating teachers?

Appendix B

Table B-1
Usefulness of PD Components among Cohort 2 Follow-up Respondents

PD Aspects		Extremely Useful		Very Useful		Somewhat Useful	
	N	*n*	%	*n*	%	*n*	%
Learning about NGSS standards and how they apply to Curriculum 2.0	66	25	37.9	33	50.0	8	12.1
Kindergarten	13	4	30.8	9	69.2	0	0.0
Grade 1	10	3	30.0	7	70.0	0	0.0
Grade 2	12	5	41.7	6	50.0	1	8.3
Grade 3	13	7	53.8	4	30.8	2	15.4
Grade 4	7	3	42.9	1	14.3	3	42.9
Grade 5	10	2	20.0	6	60.0	2	20.0
Learning about engineering design challenges	66	39	59.1	23	34.8	4	6.1
Kindergarten	13	8	61.5	5	38.5	0	0.0
Grade 1	10	6	60.0	2	20.0	2	20.0
Grade 2	12	5	41.7	7	58.3	0	0.0
Grade 3	13	9	69.2	3	23.1	1	7.7
Grade 4	7	5	71.4	1	14.3	1	14.3
Grade 5	10	5	50.0	5	50.0	0	0.0
Learning about assessment probes	66	31	47.0	28	42.4	7	10.6
Kindergarten	13	4	30.8	8	61.5	1	7.7
Grade 1	10	3	30.0	3	30.0	4	40.0
Grade 2	12	8	66.7	3	25.0	1	8.3
Grade 3	13	7	53.8	6	46.2	0	0.0
Grade 4	7	5	71.4	2	28.6	0	0.0
Grade 5	10	3	30.0	6	60.0	1	10.0
Learning about integrating technology	66	30	45.5	26	39.4	10	15.2
Kindergarten	13	7	53.8	5	38.5	1	7.7
Grade 1	10	5	50.0	2	20.0	3	30.0
Grade 2	12	4	33.3	6	50.0	2	16.7
Grade 3	13	4	30.8	6	46.2	3	23.1
Grade 4	7	5	71.4	1	14.3	1	14.3
Grade 5	10	4	40.0	6	60.0	0	0.0
Learning academic language	63	29	46.0	27	42.9	7	11.1
Kindergarten	12	2	16.7	8	66.7	2	16.7
Grade 1	10	6	60.0	4	40.0	0	0.0
Grade 2	12	7	58.3	4	33.3	1	8.3
Grade 3	13	7	53.8	4	30.8	2	15.4
Grade 4	5	3	60.0	2	40.0	0	0.0
Grade 5	10	3	30.0	5	50.0	2	20.0
Exploring MCPS science kits	64	35	54.7	10	15.6	19	29.7
Kindergarten	13	9	69.2	2	15.4	2	15.4
Grade 1	9	2	22.2	3	33.3	4	44.4
Grade 2	12	9	75.0	2	16.7	1	8.3
Grade 3	13	7	53.8	2	15.4	4	30.8
Grade 4	6	3	50.0	0	0.0	3	50.0
Grade 5	10	4	40.0	1	10.0	5	50.0

Ways to incorporate science into reading and writing	65	30	46.2	30	46.2	5	7.7
Kindergarten	13	9	69.2	4	30.8	0	0.0
Grade 1	10	4	40.0	4	40.0	2	20.0
Grade 2	12	7	58.3	5	41.7	0	0.0
Grade 3	13	3	23.1	9	69.2	1	7.7
Grade 4	6	5	83.3	1	16.7	0	0.0
Grade 5	10	1	10.0	7	70.0	2	20.0
The schedule of the PD's (i.e. one before each marking period)	66	46	69.7	17	25.8	3	4.5
Kindergarten	13	9	69.2	3	23.1	1	7.7
Grade 1	10	6	60.0	3	30.0	1	10.0
Grade 2	12	10	83.3	2	16.7	0	0.0
Grade 3	13	9	69.2	4	30.8	0	0.0
Grade 4	7	6	85.7	0	0.0	0	14.3
Grade 5	10	5	50.0	5	50.0	0	0.0

Note. There were no “Not useful at all” ratings
Note. One teacher, not assigned to a grade level, was included in the Total row, but not grade level categories.

Table B-2
Suggestions for Making the PD Sessions More Useful (*N* = 27)

Category	Verbatim Response
Scheduling Issues (*n* = 5)	• *I know scheduling can be tough, but I would suggest not making one of the meetings the Tuesday after a 3 day weekend, and also not scheduling the last two so close together.* • *Not having second and third quarter planning so close together.* • *Not to have a January meeting during mClass testing* • *It was hard meeting during the school year* • *It was a great and enriching experience. However, I wish the sessions would have been on Saturdays during the school year, that way we wouldn't have had to take off and plan for a substitute*
Provide materials, resources, electronic handouts, and better science kits (*n* = 4)	• *Providing materials to bring back to the classroom.* • *Providing attendees with resources books and materials.* • *I think it is really important that MCPS understand that the content of our Science kits is limited and incomplete. We tried to stress that to people during our sessions and it seemed to be dismissed. Luckily I am at a school where parents will try to supplement our Science kits so we can do the experiments but most teachers are not that lucky. The clay dyes children's hands, my third grade team only had 1 small bag of rock salt to make ice cream, we didn't have any gravel to make dams, the batteries don't work in the thermometers, the batteries don't work in the timers (The list goes on and on). MCPS is paying a company to provide complete Science kits and they are not doing a thorough job. Also, the amount of materials, if provided, are not enough for classes of 28 students. If teachers don't have access to materials, it makes their jobs much more difficult and students lose out on experiments. Please take this comment seriously so that teachers can do their jobs effectively and students can learn.* • *Having electronic copies of all handouts. This doesn't necessarily pertain to the science cohort, but it would also be nice if every school had copies of the text resources they used, like Picture Perfect*

	Science Lessons. Otherwise, I thought it was a fantastic experience.
Offer more trainings (n = 4)	• *I would have loved to have more trainings. These trainings took the old and boring science units and transformed them into innovative, up to date (tech) lessons. Our cohort was small. I think that this should be offered to all fifth grade teachers in the county. I found this cohort to be very useful in helping me teach science.* • *Offer it to more teachers. The STEM teacher at my school would REALLY benefit from this!* • *This is probably the most useful course I have taken in years! It would be so great if there was a "Part 2" to it!* • *No, I thought it was such a great opportunity! Ok more useful would be to offer it again so my teammate can take it.*
More hands-on activities provided (n = 2)	• *More hands on activities that we can take back to our teams. The few we did have were great and I would have loved more for each quarter.* • *More hands on activities that first graders need.*
Clearer goals and vision (n = 2)	• *Clearer description of goals of the cohort. Marketed more towards newer teachers or newer to grade level teachers.* • *I understand the NGSS practices, but I still don't completely understand where specifically (content-wise) NGSS is heading. I really signed up to be part of the cohort because I wanted to be a step ahead when the curriculum changes. However, at the March session, it was briefly mentioned that the curriculum is changing, maybe as early as next year, but I have no idea what the content or changes will look like.*
How to cover lessons (n = 2)	• *The instructors refined as they went along. Going through week by week would have been helpful for the first quarter but we didn't think of it until later.* • *The integration of lessons together. I like the idea of what lessons are important to cover. Due to limit of time, it was beneficial to look at each week and see what stands out. I think putting some lessons together would be helpful. I also think that assessments for some of the activities would be helpful too. And they should cover indicators as well as NGSS standards.*

Miscellaneous: (n = 5)	• *Having a contact sheet with the names and information of other teachers so we could discuss NGSS information in-between sessions.* • *Presenters sticking more to the curriculum.* • *Maybe to provide more kid friendly technology pieces. Most were things the teacher would do in the course of instruction. Also more options for assessment.* • *Build time into the schedule for general questions about the Science curriculum.* • *An easier way to organize the files - maybe a google folder instead of using google classroom?*
Response of No Suggestions/Only Positive Feedback (n = 10)	• *I feel that the science cohort experience was wonderful.* • *Can't think of anything.* • *No. I found the training to be extremely valuable and it changed the way I taught certain things for the better* • *I do not believe so, I love attending the session as I was a new fifth grade teacher. I left each of the sessions having knowledge about the up coming science unit with many engaging learning activities for the class. I was able to incorporate many of the websites they provided our group with into my lessons.* • *No it was awesome! Super informative and useful.* • *Not that I can think of.* • *No* • *I thought it was very beneficial to meet prior to the start of each marking period. Discussing the assessment probes, creating the vocabulary cards were all necessary to help teach the unit.* • *It was great to really to have time to explore and talk with others.* • *I thought my instructors did an amazing job filling our day(s) with all of the materials needed for the next marking period.*

Note. Teachers many have given more than one suggestion, so total suggestions exceeds 27 responding teachers.

Appendix C

Table C-1

Teacher Examples of Integrating NGSS Practices into Science Instruction by Grade Level

Kindergarten Examples
I made a science center part of my choice centers…I did some weather projects where we had a question, planned answers and developed a product. The kids asked when we were doing science again because they enjoyed it so much.
During mealworm lessons, students had to plan how they would create a habitat for their mealworms and what foods they thought their mealworms would like and then we documented which habitat/foods they liked best
Grade 1 Examples
Hands-on lessons (design and build windmills, animal habitats) develop a question to test and design experiment
Practice 2: Developing and Using Models: Quarter 4, week 1 Health Education: washing hands and germs. After learning about germs and why hand washing is important I thought having the students build models of germs would help them connect to the concept better because germs are microscopic. I used balloons, paper towel rolls, etc. to build models. Building models [allowed] them to see bacteria comes in different sizes, shapes, and colors.
Grade 2 Examples
Included more design process in the science areas, including reflection of what worked and what didn't and possibly why, collected more data and analyzed the results
Students designed their own instruments and discussed why they thought their unique design would be most successful. Also, when our butterfly net zipper broke, they brainstormed the best way to handle the situation and used verbal reasoning to explain why.
Grade 3 Examples
We created data tables for experiments. We have distinguished the difference between testable and non-testable questions, and students created their own.
My science instruction and question asking has increased tremendously after taking the course. One practice we have used is after creating models, we go back and discuss what we liked and how we could have changed our design.
Grade 4 Examples
One example is when they were [shown] the scientific process and having them go through each step as they hypothesize about what makes a plant grow best. Students generated their own questions and some used sample questions. They determined how much water to use, light to give, variables to change on a daily basis without prompting. Their results page had to be precise in calculations, documentation, and …had to include domain specific language.
One example of [Practice 3] was during MP2 when the students were learning about pollution, and they had to investigate how different pollutants would affect their eco-columns… I had the students design their own experiment (how much pollutant should they use, how often should they water, how would the collect data, etc.), and then carry out that experiment. This naturally led us into Practice 4 when we looked at and analyzed the results.
Grade 5 Examples
[For magnet unit], students worked as a team to design a new car that could be operated by using magnets. Students had to apply either the push or pull principle to make their car move. In addition, I created an obstacle track that they had to get their car to complete.
Practice 7: Engaging in Argument from Evidence. We spent time using probes where students were … providing evidence as to why they agree. The probes really helped students learn how to use evidence to support their answers. Students are now asking each other for evidence when they are working together on an investigation or design challenge.

Table C-2
Teachers' Examples of Integrating Reading and Writing into Science Instruction by Grade Level

Kindergarten
*One of the weekly literacy centers is **writing**. We revised some topics to revolve around weather, animal coverings and animal habitats. We kept a list of science **vocabulary** for students to use in their conversations and writing. A lot more of our **whole group reading** has been nonfiction science related. I probably read 2-3 science books per week.*
Every week during literacy centers I have a "science" center which re-enforces science themes from current/previous weeks. Once a week I will choose a science curriculum related text.
Grade 1
*During **reading** and **writing**, the study of the rain forest and **writing** a research paper on the rain forest.*
*Prior to each unit I introduce the **vocabulary**…I [then] add more **vocabulary** to our science word wall and review…continuously. This is vital so they can comprehend the informational text and online resources. I have them find books during media center time and I try to pull available guided **reading** text they can **read** independently to respond to in literacy centers.*
Grade 2
*Observations occur during **writing** about their thoughts, predictions and wonderings. They have also been creating creative stories about observable objects. Second grade **reading** standards include asking and answering questions, this fits perfectly with the physical and life science for our students.*
*I integrated science and **reading** when learning about life cycles, habitats, animal basic needs. I will do the research/reading part during whole group **reading** and then do the investigations during science. This gives my students more time for their investigations, hands-on activities and collaboration.*
Grade 3
*I incorporate **reading** by **reading** informational texts on the subject matter to build **vocabulary** and background knowledge. We incorporate **writing** by drawing conclusions, learning how to formulate a conclusion, and **writing** ways to improve their investigation OR come up with a new one.*
*I have found non-fiction sources for **reading** groups that complement the science lessons. This is used during the second half of the marking period when we are studying informative.*
Grade 4
*After learning about adaptations, students **wrote** a National Geographic type article about an animal and its adaptations. After observing and measuring weather, students **wrote** a letter to a friend who would be visiting our area about what clothing to bring based on their weather observations. Students are currently working on a Rock Fact sheet, where they pick a rock, describe what type of rock it is, how the rock is formed, and where the rock can be found.*
*Each lesson required them to **read** a passage about the topic in their **Reading** block time and **write** a summary of information or I solicited their opinions on different scientific facts. One example is our current unit on fossils. We **read** many short passages on fossils in the **reading** block, answer comprehension questions to check for understanding of the content, and they are given an inquiry **writing** project asking them how discovering fossils helps us understand ancient species such as the dinosaurs.*
Grade 5
*Students **read** a text or article that covers the topic of that quarter and we apply non-fiction **reading** standards to it. This way they get both the background knowledge for science and **reading** instruction. In **writing** students are often asked to **write** short informational or opinion pieces about what they do in science. In addition, students have **written** opinion pieces on important science topics.*
*I have had my students argue their scientific understanding though both informative and persuasive **writing**. We have **written** letters to NASA informing them about models we have made that would be useful for their facilities to use to help teach children earth and space science.*

Appendix D

Table D-1
Extent of Change Among Cohort 2 Follow-up Respondents

Changes		Greatly Increased		Somewhat Increased		No Change/ Decreased	
	N	*n*	*%*	*n*	*%*	*n*	*%*
Connect science with reading and writing							
Kindergarten	13	11	84.6	2	15.4	0	0.0
Grade 1	10	4	40.0	5	50.0	1	10.0
Grade 2	11	5	45.5	6	54.5	0	0.0
Grade 3	13	5	38.5	7	53.8	1	7.7
Grade 4	7	4	57.1	2	28.6	1	14.3
Grade 5	10	4	40.0	3	30.0	3	30.0
Utilize formative assessment probes							
Kindergarten	13	2	15.4	10	76.9	1	7.7
Grade 1	10	3	30.0	7	70.0	0	0.0
Grade 2	11	9	81.8	2	18.2	0	0.0
Grade 3	13	8	61.5	5	38.5	0	0.0
Grade 4	7	5	71.4	2	28.6	0	0.0
Grade 5	10	5	50.0	4	40.0	1	10.0
Use MCPS science kits							
Kindergarten	13	8	61.5	3	23.1	2	15.4
Grade 1	10	0	0.0	7	70.0	3	30.0
Grade 2	11	6	54.5	4	36.4	1	9.1
Grade 3	13	8	61.5	3	23.1	2	15.4
Grade 4	7	3	42.9	3	42.9	1	14.3
Grade 5	10	3	30.0	4	40.0	3	30.0
Spend time on science instruction							
Kindergarten	13	5	38.5	7	53.8	1	7.7
Grade 1	10	3	30.0	6	60.0	1	10.0
Grade 2	11	5	45.5	5	45.5	1	9.1
Grade 3	13	7	53.8	6	46.2	0	0.0
Grade 4	7	2	28.6	3	42.9	2	28.6
Grade 5	10	5	50.0	3	30.0	2	20.0
Use technology in science instruction							
Kindergarten	13	5	38.5	8	61.5	0	0.0
Grade 1	10	4	40.0	4	40.0	2	20.0
Grade 2	11	2	18.2	7	63.6	2	18.2
Grade 3	13	2	15.4	10	76.9	1	7.7
Grade 4	7	3	42.9	3	42.9	3	42.9
Grade 5	10	6	60.0	4	40.0	0	0.0