



The Implementation of the Wolf Trap Early Childhood STEM Learning Through the Arts AEMDD Grant Project

Interim Evaluation Report

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Introduction

The Arts in Education Model Development and Dissemination (AEMDD) grant to Wolf Trap Foundation for the Performing Arts, Institute for Early Learning Through the Arts (WT), supports the development, implementation, and dissemination of a research-based program of professional development (PD) that equips teachers to infuse mathematics instruction with arts strategies in their prekindergarten and kindergarten classrooms. The literature refers to this approach as *arts integration*, or instruction that integrates content and skills from the arts with content and skills from other core subjects, with the goal of increasing learning in both areas (Ruppert & Habel, 2011). For instance, a teacher might integrate mathematics and dance content by teaching about patterns with repeated dance movements, such that learning in one subject enhances learning in the other.

The Wolf Trap project team¹ developed and provides the PD program, which includes: (1) annual summer PD Institutes and teacher meetings as well as (2) in-classroom coaching time during the school year, a research-based strategy often called the artist residency model (Burnaford, 2007). In the multiday summer PD Institutes, teaching artists and teachers explore arts strategies and mathematics content and work in teams to develop standards-based performing arts and mathematics experiences. In Wolf Trap's artist residencies, teaching artists work with teachers in a cycle of coaching (i.e., plan, model, co-teach, debrief).

AIR is conducting an evaluation of the Wolf Trap AEMDD approach that addresses the following four research questions (RQs):

Implementation

1. To what extent does the Wolf Trap PD represent six features of high quality professional development? These features include: collective participation, form, duration, content, active learning, and coherence (Garet, Porter, Desimone, Birman & Yoon, 2001).
2. Is the Wolf Trap PD implemented with fidelity? That is, does the WT PD program (summer PD Institutes and school-year residencies) deliver preparation to classroom teachers to infuse performing arts-based strategies into their mathematics instruction, as intended?

Outcomes

3. What is the impact of the Wolf Trap PD on prekindergarten and kindergarten teachers' use of performing arts and mathematics strategies?
4. To what extent do students in the study treatment schools demonstrate better mathematics knowledge and skills than students in the comparison schools?

¹ We refer to the Wolf Trap project team throughout this report, which includes the grant director and manager, the associate director for PD at Wolf Trap's Institute for Early Learning Through the Arts, specialists who routinely plan artist activities in multiple districts, the grant program coordinators and assistants, and the teaching artists on contract to WT for this grant.

AIR hypothesizes the WT PD will enhance teachers' mathematics instruction and student learning of mathematics.

This report addresses the implementation research questions 1 and 2 and serves as an interim report, focusing on the experiences in the first group of treatment schools participating in the grant. A next report, in summer 2014, will focus on the outcomes, research questions 3 and 4, and include data on all participants.

This report is organized as follows: Part 1 describes the conceptual background, study design, data sources, and collection for the study as a whole. It also introduces the analysis approach for the implementation data used in this report. Parts 2, 3, and 4 reflect on the implementation of the WT approach for the first three treatment schools participating in the first two years of the grant project (2011-13). Part 2 describes the ways in which the WT approach meets features of high quality PD. Part 3 describes the fidelity of implementation of the WT approach. Part 4 presents a summary of the conclusions and identifies strengths and challenges of the implementation of the approach. Appendix A provides details regarding the analysis procedures.

Part I. Conceptual Background and Data Sources

In this section, we briefly refer to the literature that informs the logic model for the evaluation and underlies our research questions about implementation as well as impact. We present our study design and data sources and conclude with a description of the analysis approach for the first two RQs, about implementation.

Our logic model is based on research in four areas: features of effective PD, fidelity of implementation, arts integration, and mathematics instruction for early childhood.

Conceptual Background

Features of Effective PD

Researchers have described two main paths from professional development to student outcomes: teacher knowledge and instructional practices (Kennedy, 1998). Wolf Trap's PD focuses on linking arts-based practices with practices of mathematics instruction and delivering the PD directly to the participating teachers. In this evaluation, we investigate whether the Wolf Trap model of professional development reflects the research-based features shown to affect teacher knowledge and practice: form, duration, collective participation, focus on content, active learning, and coherence (Garet et al., 2001). Researchers studying PD for teaching reading, mathematics, and writing have studied these features (Wilson, 2013; Sun, Penuel, Frank, Gallagher, & Youngs, 2013). Saraneiro and Goldberg have also studied these features of PD in the context of arts in education (2011).

Fidelity of Implementation

The literature indicates that implementing PD in a standard way (across all participating schools and teachers) contributes to teacher and student outcomes. Fidelity of implementation of a planned curriculum or instructional approach has been shown to affect teacher practice and student outcomes (Durlak & DuPre, 2008). Additionally, factors outside of a planned intervention may influence the quality and fidelity of implementation (Durlak & DuPre, 2008). In this evaluation, AIR investigates the extent to which the WT PD program, including the PD Institutes and residencies, is implemented as designed. We also take note of factors participants report and observers note as possible influences on fidelity of implementation.

Arts Integration

The Wolf Trap model is part of a tradition of models of arts-integrated instruction (Burnaford, 2007). Emerging from research on arts integration programs is a list of features proposed to be critical to well-crafted integrated instruction (Baker et al., 2003, cited in Rabkin & Redmond, 2004, p. 137):

- a) Teacher-artist teams link an art form and an academic discipline
- b) Student groups' work in the art form is central to the experience and to continuous assessment
- c) Content includes material related in meaningful and direct ways to students' experiences

- d) Units have a balanced focus on academic content, academic skills, arts skills, and arts content
- e) Units include basic skills and higher order skills
- f) Units usually culminate with an artistic product that demonstrates student learning of content and skills and contributes to the public culture of the school community

Rabkin and Redmond (2004) additionally note that institutional, school, and community-level elements (e.g., districts' arts standards, current PD for teachers, and schools' prior experience with arts) are important for arts integration initiatives, and we consider our implementation investigation in light of this context. In this evaluation, we investigate the extent to which classrooms show evidence of arts-integration features. We also document, where available, participant perceptions about organizational characteristics and the implementation of this arts integration effort.

Mathematics Learning in Prekindergarten and Kindergarten Classrooms

AIR's logic model has been informed by the recent National Research Council (NRC) review of literature on mathematics learning in early childhood (Cross, Woods, & Schweingruber, 2009). The literature the NRC panel reviewed indicated, for example, that early childhood classrooms typically involve blending of curricular areas, may cover a wide range of knowledge areas or topics in mathematics, and may involve fewer instructional activities for children than would be expected. The NRC review also indicated which instructional strategies are supportive of early childhood mathematics and have been shown through research to be positively related to student achievement (e.g., use of formative assessment, use of certain materials and activities, use of extensive feedback, and a focus on conceptual knowledge, including real world context and explicit instruction) (Cross et al., 2009).

Study Design

The evaluation of the Wolf Trap PD program is based on a randomized controlled trial in which volunteer schools were randomly assigned to the treatment and comparison conditions. This report focuses on the implementation of professional development for teachers in an initial group of treatment schools (research questions 1 and 2), and the final report will focus on outcomes for teachers and students in all schools (research questions 3 and 4). In this section, we explain the overall study sample, measures and data collection, and analytic approach.

Sample

Wolf Trap planned for a sample of 10 treatment and 10 comparison schools. The Wolf Trap project team undertook two recruitment efforts to encourage schools to volunteer, in 2011 and in 2012. The result was two groups of schools participating in the grant, six in group 1 and 12 in group 2. The PD treatment was scheduled for each group of schools such that groups of schools would participate for two full years in Institutes and teaching artist residencies.²

² In the first group of schools recruited (three treatment and three comparison), all schools participated for two years. This report considers implementation for the teachers in the first group of treatment schools.

To recruit schools, Wolf Trap and its partner school district worked with the superintendent's office, the research office, and the Title I office to disseminate information about the study in the superintendent's newsletter, at Title I principal meetings, and in letters to principals. The information in the communications explained the study conditions and requested that teachers from prekindergarten and kindergarten classrooms in each school consider participation. Principals in schools considering participation asked teachers about their interest in the study. Schools that were willing to participate in the study were randomly assigned to treatment and comparison conditions.

- At the time of this report, there were 10 schools in the treatment condition and 8 schools that remained in the comparison condition.
- The average enrollment in treatment schools was 769 and the median percentage of students receiving free or reduced-price lunch was 50.
- The average enrollment in comparison schools was 708 and the median percentage of students receiving free or reduced-price lunch was 50.

In each school, prekindergarten (including Head Start) and kindergarten teachers were invited to participate. The number of prekindergarten and kindergarten classrooms in each school varied, as did the number of teachers who elected to participate and continued participation over two years. Overall, in the treatment schools, 46 percent of teachers taught kindergarten and 43 percent taught prekindergarten. In the comparison schools, 60 percent of teachers taught kindergarten and 32 percent taught prekindergarten. The small percentage of other teachers (from 8 percent to 11 percent) participating included special education teachers who worked with multiple classrooms and a few teachers of combined kindergarten and grade 1 classes.³

The numbers of students in classrooms varied as well, with both larger (21 students) and smaller (six students) classes represented. The study design called for the selection of eight students from each classroom for the assessment of mathematics knowledge, the outcome measure.

In each year of the implementation, there was some mobility of teachers in the sample of schools. This movement included the addition of new participants, study withdrawal, grade-level and school re-assignment. For example, in one treatment school where there were already five participating teachers, three special education classroom teachers joined the study in Year 2 of their school's cycle. The original goal for the overall teacher sample was 80 teachers (40 in treatment and 40 in comparison schools). A total of sixty-four teachers (group 1 and group 2 combined) responded to the baseline survey. The evaluation final report will draw upon data for all participating teachers.

Data Collection

AIR's evaluation of the Wolf Trap AEMDD project draws on multiple data sources from teachers, teaching artists, and students. Table 1 shows data collection activities, participants, and schedule of data collection. Links to the instruments are in a footnote below. A description of the instruments follows.

³ Some variability in types of classrooms in each school was likely related to school category (Title I), location, and service to special populations, such as students with special needs.

Table 1. Data Collection and Participants, Overall Evaluation of the Wolf Trap Project

Data collection activity	Participants	Schedule of data collection
Teacher baseline survey ^a	All treatment and comparison teachers	Group 1: summer 2011 (treatment), fall 2011 (comparison) Group 2: summer 2012 (treatment), fall 2012 (comparison)
Observations of classrooms ^b	All treatment and comparison teachers	Before and after residencies (Some teachers in group 2 are still participating in residencies in 2013–14.)
Online survey of teachers regarding Wolf Trap services	All treatment teachers	Annually conducted by Wolf Trap teachers
Observations of the PD Institutes ^c	Treatment teachers and teaching artists	Each summer when the Institute is delivered and midyear meetings for teachers and teaching artists
Teaching artist residency planning forms ^d and lesson plan forms ^e	Teaching artists and treatment teachers in residency activities	Submitted at the end of each group of residency visits by artists for assigned teachers (selected sample used for analysis)
Interviews with teaching artists ^f	All teaching artists	June 2013
Early Math Diagnostic Assessment (EMDA), an instrument developed by Pearson Raw scores for students in Group 1 and Group 2 classrooms	Sample of students from each treatment and comparison classroom	Baseline and two follow-up administrations for sampled students (follows students for a second year to their next grade)

^a Survey available at: http://www.wolftrap.org/~media/files/pdf/education/wolf_trap_teacher_survey.ashx

^b Classroom observation form available at: http://www.wolftrap.org/~media/files/pdf/education/classroom_observation_form.ashx

^c PD Institute observation form available at: http://www.wolftrap.org/~media/files/pdf/education/blank_2012_pd_obsvform.ashx

^d Example residency planning form available at: http://www.wolftrap.org/~media/files/pdf/education/Planning_Form.ashx.
Residency planning form analysis rubric available at: http://www.wolftrap.org/~media/files/pdf/education/blank_residency_planning_form_analysis_spreadsheet.ashx

^e Example lesson plan available at: http://www.wolftrap.org/~media/files/pdf/education/Early_STEM_Arts_Lesson_Plan.ashx.
Lesson plan analysis spreadsheet available at: http://www.wolftrap.org/~media/files/pdf/education/blank_lesson_plan_analysis_spreadsheet.ashx

^f Interview protocol available at: http://www.wolftrap.org/~media/files/pdf/education/Interview_protocol.ashx

Wolf Trap and AIR first sent introductory letters about the project to principals and teachers to explain data collection activities. Additionally, Wolf Trap and AIR shared project information (such as the schedule and the purpose of data collection) with teachers and parents at the start of the study, at the survey administration, prior to classroom observations, and prior to sampling students for participation in the EMDA assessment.

Surveys

AIR administered the Professional Development and Instructional Practice (PDIP) survey to treatment and comparison teachers. The PDIP survey contains items about teacher classroom level, size, teaching experience, PD experience, and instructional practices teaching mathematics and has been used in two National Science Foundation (NSF) studies by AIR, investigating the impact of PD on teacher practices.⁴ The items have been analyzed and shown to be reliable and valid. Wolf Trap also conducted an online “services-focused” survey with treatment teachers.

Observation Forms

Two observation forms were designed to collect data. The observation form for the summer PD Institutes was based on PD observation forms used in two national studies of PD impact on reading and mathematics. This form was grounded in the agenda for the Institute and the elements of the PD that were expected (content focus of mathematics, arts, linking arts and mathematics). The classroom observation form delineated the same content foci, contained a section for narrative description of instruction observed, and a scale of arts integration.

Documentation From Artists

AIR examined teaching artists’ residency planning forms and lesson planning forms, provided by Wolf Trap. The residency planning forms include the teaching artists’ overall plan for coaching classroom teachers over the duration of their partnership. These forms outline a schedule, and include the curriculum standard for the residency, as well as skills and goals for students and teachers. A teaching artist lesson plan form is a detailed description of a particular class segment. Lesson plan forms prompt teaching artists to indicate arts and mathematics concepts, PD skill focus, identification of vocabulary, objectives, teacher questions, description of lesson procedure, assessment strategies, modifications, and extension experiences. The individual lesson plans are intentionally structured for coherence with the residency form.

Interviews

AIR also interviewed the nine teaching artists working with the first group of treatment teachers in 2011–13. These interviews, conducted by phone with two researchers, asked artists about their overall experience in the role, their preparation for the Wolf Trap project, and their views about the experience of the teachers with whom they worked and challenges in preparation and implementation.

Student Assessment

The EMDA was selected with the approval of the partner district and the AEMDD project officer. EMDA is administered to students on a one-to-one basis. The items in the assessment reflect the mathematics curriculum in prekindergarten and kindergarten classrooms.

⁴ The studies examined the PD delivered by Math/Science Partnership Projects funded by NSF.

Analysis Approach for Research Questions 1 and 2

In the 2014 final report, we plan to use statistical analyses (means, standard deviations, correlations, and hierarchical linear model analysis) to assess the outcomes for teacher practice and student achievement, comparing results for treatment teachers and students and comparison teachers and students.

To address the two implementation research questions, AIR staff reviewed transcripts of interviews with teaching artists, materials from the PD Institutes (PD agendas, participant binders, and observation notes), and materials that document teaching artists' coaching work with teachers (residency plans and lesson plans). We began with a model of the components of the WT PD approach which emerged from the observation of the 2011 Summer Institute.⁵ We defined each construct in our logic model (i.e., arts strategies) and reviewed all data sources to determine whether they were appropriate sources for each implementation question. We created rubrics to analyze evidence of the constructs in each source. As we wrote about the results, we looked at each separate source of data to determine whether findings and examples could be supported in multiple data sources.

The two *implementation* research questions are:

1. To what extent does the Wolf Trap PD (summer PD Institutes and coaching) represent six features of high quality professional development? (These features are collective participation, form, duration, content, active learning, and coherence; Garet et al., 2001).
2. Is the Wolf Trap PD implemented with fidelity? That is, does the WT PD program (summer PD Institutes and residencies) deliver preparation to classroom teachers to infuse performing arts-based strategies into their mathematics instruction, as intended?

A detailed description of analysis procedures can be found in appendix A with links to the rubrics developed for analysis. In brief:

- For the PD Institute analysis, AIR developed a rubric to prompt analysts to observe each PD activity in a consistent way. Then analysts reviewed the collective set of PD Institute materials (PD agendas, participant binders, and observation notes).
- For the analysis of teaching artists' coaching work with teachers, AIR gathered teaching artists' documentation (residency plans and lesson plans) from Wolf Trap. From a larger group of documents, AIR created a sample of 9 residency planning forms and 20 lesson plan forms. In determining the sample, we randomly selected forms from each teaching artist separately, so that our sample included variety across teaching artists. AIR then developed a rubric for the residency planning form and a rubric for the lesson plan form, so that analysts would review these forms in a consistent way.
- For the analysis of teaching artists' interviews, we compiled results to each question and reviewed themes, consensus points, and variations in responses to each question.

⁵ The working model which emerged from the Institute materials and observation notes is found in the third tab of the PD Observation form http://www.wolftrap.org/~media/files/pdf/education/blank_2012_pd_obsvform.ashx

Part II. Features of High Quality PD

In this section we report on the extent to which the WT PD Institutes and residencies exhibit the six features of high quality PD—form, duration, collective participation, content, active learning, and coherence—that have been shown to influence teacher practice and student learning (Garet et al., 2001).

As table 1 and appendix A suggest, we drew upon our analysis of the PD events and materials, including the observations of PD Institutes, documentation of the teaching artist residency (lesson plans and teaching artist planning forms), and the interviews with artists.

Form

The term *form* refers to what professional development activities consist of, or how they are organized (Garet et al., 2001). Research suggests that professional development activities that are incorporated in teachers' daily school work (such as coaching, mentoring, and in-school discussion groups) provide more opportunities for active learning and encourage greater coherence of activities with teachers' and schools' larger goals and teachers' communications with others than professional development not incorporated in their school work. Furthermore, in-school coaching, considered a "reform" type of PD, is said to help sustain the contributions of professional development over time (Garet et al., 2001; Hargreaves & Fullan, 1992; Little, 1993; and Stiles, Loucks-Horsley, & Hewson, 1996.)

The Wolf Trap team first prepared artists for their work with teachers, and then worked with artists to provide training at the summer PD Institutes. During the school year 'treatment', artists provided modeling and coaching to teachers, continuing WT's approach. The WT model includes PD that is incorporated into teachers' daily work (residencies), as well as PD that orients teachers, prior to the school year, to the arts integration strategies that will be the focus of the coaching they receive (the summer PD Institutes). The evidence (observations of PD Institutes, PD binder materials, and residency plan and lesson plan analysis) indicates that WT and the teaching artists delivered PD that included training for artists, summer PD Institutes, and coaching, all of which were characterized by action and "reform" orientations to PD, as compared to traditional PD sessions.

Training Teaching Artists

Wolf Trap staff provided 16 days of initial training for teaching artists during the planning year. In these training sessions, early childhood mathematics specialists gave presentations about how children learn mathematics, and about the mathematics content standards for prekindergarten and kindergarten students. With this knowledge base, teaching artists developed arts-integrated experiences covering a variety of mathematics topics. The teaching artists presented these experiences to their colleagues and the early childhood mathematics specialists, who gave feedback. Over the planning year, the artists also worked in non-study schools, piloting lessons and arts-integrated experiences. After completing this training, teaching artists co-planned the summer PD Institute together with Wolf Trap staff.

In the second year of implementation, two additional teaching artists were trained, to meet the needs of the two concurrent groups of teachers participating in the project. As part of this training, the two teaching artists attended a four-day PD Institute, participated in classroom residencies, and attended ongoing working group meetings with their colleagues in the project.

PD Institutes

In the implementation years (2011, 2012, and 2013), WT delivered summer PD Institutes. In the Institutes, artists provided instruction on content and strategies, while WT project staff discussed the requirements of the grant and provided resources for study teachers.

The PD Institutes were slightly different each year because of the approach to engaging groups of schools in the study. The PD activities in the summer 2011 (for group 1) included four and a half days of training (the Institute), and a one-day intensive PD session was provided for group 1 teachers who missed the summer Institute. In summer 2012, the PD Institute provided training for both group 1 teachers (who would begin their second year of residencies) and group 2 teachers (new to the program). Group 1 teachers participated in three days of Institute activities, and group 2 participated in four and a half days of Institute activities. In summer 2013, group 2 teachers were expected to participate in three days of Institute activities.

Residencies

In residencies, teaching artists work with teachers in a cycle of coaching (i.e., plan, model, co-teach, debrief), focused on the Wolf Trap approach of integrating arts-based strategies into mathematics instruction. Each school year (with two-semester-long 16-session⁶ residencies) included:

- A first semester orientation, classroom observation, and pre-residency planning meeting
- Classroom sessions led by the artist (10 in the first semester; fewer in the second semester)
- Co-planning meetings where teaching artists and teachers created lesson plans (two in the first semester; more in the second semester)
- Sessions led by the classroom teacher (two in the first semester; more in the second semester)

Teaching artists began the residency by leading experiences and working to increase teachers' capacity to integrate arts and mathematics, such that teachers would increasingly be the leaders of these lessons during the school year. Each teacher was assigned to work with one teaching artist for one year. If the teacher remained in the study for two years, he or she would work with two different teaching artists.

Duration

The term *duration* refers both to the time span of the PD effort and the number of contact hours committed to the effort (Garet et al., 2001). Yoon, Duncan, Lee, Scarloss, and Shapley (2007)

⁶ A "session" denotes a visit by a teaching artist.

reviewed nine rigorous studies of PD in which the PD was delivered to the teacher directly; they found that an average of 49 hours of PD boosted student achievement markedly. The span of the PD activities in these studies varied, but mostly occurred within a year. The Wolf Trap model has been designed to meet the recommended standard in contact hours of PD over two years (see Table 2).

Table 2. Duration: Planned Hours of PD per Teacher Over Two Years

Activity	Hours/unit	Number of units	Total
Summer PD Institute in year one	6/day	4.5 days	27 hours
Summer PD Institute in year two	6/day	3 days	18 hours
Teacher meetings in year one	4/day	1 day	4 hours
Teacher meetings in year two	4/day	1 day	4 hours
Residencies in year one	0.75/visit	16 visits a semester * 2 semesters	24 hours
Residencies in year two	0.75/visit	16 visits a semester * 2 semesters	24 hours
TOTAL (two-year treatment)	101 hours		

Collective Participation

Collective participation in PD refers to including groups of teachers from the same school, the same department within the school or, ideally, the same grade level in the school (Garet et al., 2001). Research has shown that PD is more effective if teachers in the same department or grade level participate in PD together (Garet et al., 2001). Collective participation is thought to foster opportunities for collegial development that improves professional development in the short term and helps sustain it over the long term (Ball, 1996; Knapp, 1997; Talbert & McLaughlin, 1993; Elmore, 2002; Sun et al., 2013).

WT sought to facilitate collective participation. WT aimed to recruit prekindergarten and kindergarten teachers at each participating school; however, not all teachers in each school chose to participate. Further, the evidence—the documentation maintained by Wolf Trap regarding participation in the PD events—indicates that the level of teacher participation varied among the groups of eligible participating teachers in the treatment schools. Therefore, both the extent to which collective participation occurred and the dosage of treatment received by the teachers varied, as indicated in table 3.

Table 3. Treatment Dosage for Group 1 Teachers, as Implemented in Institutes and Residencies 2011–13 (3 schools)

	Summer Institute 2011	One-Day Institute, Fall 2011 (for teachers not participating in the Summer Institute)	Summer Institute 2012	Residencies
Number of teachers in group 1 participating, by event	10 (full days) 1 (half days) 1 (primarily full days, 1 half day)	12	8 (full days) 2 (mix of full and half days)	14 (2 full-years participation) 3 (1 full year participation) 3 (1 residency, half year participation) 6 (no residency participation, left project in October of first year)

- Of the 26 teachers who began as participants in the treatment group in group 1, 12 participated in all days of the 2011 summer PD Institute and the residencies.
- Of these 26, there were 12 teachers who indicated they planned to be in the study, but did not attend the 2011 summer PD Institute because of schedule conflicts. Wolf Trap created a one-day intensive workshop for these teachers in the fall before the residencies began. Nine of these 12 teachers left the study during the first semester of the school year and 3 of these 12 teachers left the study at the end of the school year.
- Of the 14 group 1 treatment teachers remaining in the second year, 10 attended the 2012 summer PD Institute.
- In fall 2012, an additional three teachers began participation in one of the group 1 treatment schools. They participated in the 2012 summer PD Institute with the group 2 treatment teachers.

Content Focus

The term *content* refers to the topics that are covered within the professional development session. Professional development that focuses on what students are expected to learn—and how students learn the subject matter—appears to support teacher knowledge and practice in ways that improve student achievement (Cohen & Hill, 2001; Garet et al., 2001; Kennedy, 1998; Carpenter, Fennema, et al., 1989). For example, McCutchen et al. (2002) found that a professional development intervention that focused on deep content knowledge about the structure of English language and how children learn to read produced effects on teacher knowledge, practice, and student achievement in kindergarten and first grade.

In the context of the Wolf Trap approach, we would expect the WT PD to:

- Present what students need to know (mathematics content, and arts discipline content and techniques)

- Present what teachers can do to help students learn (this includes understanding how to infuse arts strategies in mathematics instruction, and may include how to use research-based early childhood pedagogy strategies)

Teachers are expected to come to the WT PD program with expertise in early childhood mathematics instruction and pedagogy from their education and classroom experience. We would expect the WT PD’s primary content contribution to be providing training for infusing arts-based teaching strategies into mathematics instruction.

The evidence—the PD schedules, our observations, and the documentation—confirm that the content covered in the PD Institutes and residencies was primarily linking arts and mathematics, and to a lesser extent, included what students were expected to know in mathematics, as well as pedagogy strategies teachers could use to instruct students at the early childhood level.

PD Institutes

The 2011 and 2012 PD Institutes each included four and a half days of instruction, in which teaching artists taught teachers via modeling, lecture, discussion, small group work, and question-and-answer sessions. In the 2011 PD Institute, the group 1 teachers began on August 2 and ended on August 6. In the 2012 PD Institute, the group 2 teachers participated in their summer PD Institute on August 6–10. Group 1 teachers participated in a concurring summer PD Institute, August 7–9. In 2012, the two groups of teachers (group 1 and group 2) participated in separate activities tailored to their level of experience with the residencies; however, there were several opportunities for joint activities and reflection (e.g., using the book *Muncha Muncha Muncha* by Candace Fleming and G. Brian Karas to integrate arts and mathematics teaching).

For each Institute, WT prepared a binder as a resource for teachers and teaching artists. Each Institute binder included the schedule, information about WT, district standards, early childhood mathematics and performing arts resources, and lesson plans created by teaching artists (some of these lessons⁷ were demonstrated during the Institute, and others were intended to be used as resources during the residencies). The following table (Table 4) presents detailed descriptions of the agenda components of the WT Institutes. It highlights features of content, active learning, and coherence.

⁷ In 2012, the binders also contained lesson plans for the energizers, which were used in the three-day session for the returning group 1 teachers.

Table 4. Summary of Components, Content and Related Features of the Wolf Trap Institutes

Institute Components	Description of Content and Identification of Related Features
Residency and overall project information	<ul style="list-style-type: none"> Throughout the Institute, members of the Wolf Trap project gave brief introductions and procedural presentations about the residencies, administrative paperwork, the evaluation, and the availability of resources for teachers.
Mathematics content	<ul style="list-style-type: none"> In each year, on day 1 of the Institute, a presenter from the local Office for Children gave an overview with current thinking in the field about how children learn mathematics content and what students in prekindergarten and kindergarten are expected to know and be able to do. Additional resources came from mathematics experts via videos and Institute participation. Coherence with district standards was evident as the presenters specified the content standards; binders contained district documents with standards and pacing information.
Arts discipline content	<ul style="list-style-type: none"> In each year, on day 1 of the Institute, teaching artists from the fields of dance, music, and drama each gave 30- to 35-minute presentations introducing teachers to the art forms and their fundamental elements. There were other selected times during the Institutes when artists presented information about their performing arts disciplines. Active learning was evident as teachers were engaged in demonstrations of performing arts. Teachers used props and materials in the arts, practiced what they were learning, and often experienced the activities in the role of student.
Using arts-integrated strategies to teach mathematics (may include both arts and early pedagogy strategies)	<ul style="list-style-type: none"> The majority of the instruction-focused time at the Institutes focused on arts integration, or linking performing arts and mathematics such that learning in one area enhances the other, and all 30-plus lesson plans in the PD Institute binders focused on this approach. These segments involved coherence (linked to standards) and were notable for the expectation that teachers would be active participants.
Small group discussions among teachers regarding current practice	<ul style="list-style-type: none"> In days 2 and 3 of the full summer PD Institute, after each artist presented initial examples of arts-integrated strategies as related to specific mathematics topics, teachers assembled in small groups with artists to discuss their current classroom practices regarding that topic (e.g., number sense) and their perceptions of how the art-integrated strategies would work for their students. Teachers sometimes led discussions in these meetings and discussed the importance of student learning needs and classroom features, evidencing active learning. Each of these small group sessions began with a discussion of the current instructional attention to content areas, providing evidence of coherence.

Institute Components	Description of Content and Identification of Related Features
Early STEM/Arts connection to early childhood literature	<ul style="list-style-type: none"> • A foundational component of the Wolf Trap Institute for Early Learning Through the Arts is the use of literature, both books and oral stories, as the content which inspires the use of arts strategies. Each Institute included a block of time in which teachers would examine literature provided by the WT project staff. They would review the entire selection of books set out on tables, identify a story, explore the story and identify the story that could be used to teach or link arts and mathematics, and share ideas about use of literature with colleagues and artists. In the PD Institute binders, among the approximately 30 lesson plans, at least 10 grew from the elements of iconic stories, such as <i>Caps for Sale</i>; <i>Quillworker: A Cheyenne Legend</i>; and <i>Gorilla! Gorilla!</i>⁸ • Teachers found and discussed mathematics content in stories and related the use of the literature to current curriculum, continuing the emphasis on coherence. • These portions of the Institute allowed teachers to be actively engaged in learning as they made selections and participated in discussions.
Parent involvement	<ul style="list-style-type: none"> • In the PD Institutes, the participants discussed approaches to involve parents in activities similar to ones their children were experiencing in class. In the first summer Institute, the Wolf Trap project team introduced the parent component as a key element in the Wolf Trap approach and dissemination plan to teachers. In the three-day summer 2012 Institute, the returning group 1 teachers met with a representative of the partner school district's districtwide school-community office who introduced current district parent outreach activities and services. Teachers also had time periods to work with their teaching artists to describe ways they were already reaching out to parents, brainstorm ways to engage parents further, and develop specific strategies to do so in the coming year. Teaching artists reported that the parent outreach activities already developed by and with teachers included creating a newsletter and inviting parents to a demonstration of arts-integrated mathematics strategies. Teaching artists also noted ways to extend their planned lessons through activities that students and parents could do together at home.
Energizers	<ul style="list-style-type: none"> • Activities of from 5 to 15 minutes were designed and delivered by teaching artists for all Institute attendees each day. Each day began and closed with an energizer, and sometimes energizers were used as transitions during the schedule. The purposes of the energizer activities were to continue to illustrate arts-integrated activities in the performing arts disciplines, bring together all participants in one uniform activity, infuse physical activity into the day's schedule, and generally have fun. • In each energizer, teachers were actively engaged in using materials and practicing activities that could be used in their classrooms.

The following exhibits represent the Institutes at a glance. Energizers and closers were part of each day's agenda.

⁸ *Caps for Sale* is written by Esphyr Slobodkina. *Quillworker: A Cheyenne Legend* is written by Terri Cohlene and illustrated by Charles Reasoner. *Gorilla! Gorilla!* is written by Jeanne Willis and illustrated by Tony Ross.

Table 5. 2011 Institute Schedule at a Glance (Group 1 Treatment Teachers)

Tuesday	Wednesday	Thursday	Friday	Saturday
<p>Mathematics content overview</p> <p>Dance elements</p> <p>Music elements</p> <p>Drama elements</p> <p>Connections between arts/mathematics, curriculum standards</p>	<p>Mathematics/arts experiences in number and number sense and debrief</p> <p>Discussion/brainstorm and share</p> <p>Discussion: working with children in mathematics processes</p> <p>Mathematics/arts experience in geometry and debrief</p> <p>Drama</p> <p>Dance</p> <p>Music</p> <p>Discussion/brainstorm</p>	<p>Mathematics/arts experiences in measurement and debrief</p> <p>Drama</p> <p>Dance</p> <p>Drama</p> <p>Music</p> <p>Drama</p> <p>Discussion and share</p> <p>Overview of residency structure and team discussion: planning and collaboration</p> <p>Mathematics/arts experiences in data analysis and probability and debrief</p> <p>Drama</p> <p>Dance</p> <p>Music</p> <p>Discussion/brainstorm and share</p> <p>Mathematics/arts experiences in algebra and debrief</p> <p>Music</p> <p>Dance</p> <p>Drama</p> <p>Discussion/brainstorm</p>	<p>Demonstration of an entire lesson and debrief</p> <p>Review residency forms with debrief</p> <p>Team lesson planning</p> <p>Demonstration of lessons by teams</p> <p>Technology resources</p>	<p>Examination of children’s literature and lesson planning</p> <p>Share ideas</p> <p>Parent components: review of each school’s parent outreach and brainstorm ideas for parent involvement</p> <p>Timelines/instructions/next steps</p> <p>Questions</p>

Table 6. Three-Day Institute 2012 at a Glance (Group 1 Treatment Teachers)

Tuesday	Wednesday	Thursday
<p>Institute overview</p> <p>Meet with artists for coming year</p> <p>Artists and teachers share experience and breakthrough moments</p> <p>Adult experience in performing arts</p> <p>Energizer</p> <p>Presentation on family involvement (FCPS)</p> <p>Wolf Trap parent offerings</p>	<p>Working groups address parent component planning</p> <p>Peer sharing with teacher groups</p> <p>Energizer</p> <p>Working groups develop arts and mathematics activities</p> <p>Group and personal sharing</p>	<p>Integrating arts using one book for all three art forms</p> <p>Working groups focused on literature and arts and mathematics content</p> <p>Energizer</p> <p>Working groups meet on student and classroom topics</p> <p>Logistics and next steps</p>

Residencies

The analysis of residency plans confirms that teaching artists planned to continue the content focus (on infusing mathematics instruction with arts-based teaching strategies, and on teaching mathematics and arts) that started in the PD Institutes.

In seven of seven residency plans (a sample selected from the 2011–12 and 2012–13 residencies), artists reported that by the end of the residencies, teachers would be able to:

- Teach mathematics concepts through movement
- Use selected best practices for singing, movement, and storytelling with young children and create/manage child-centered music, movement, and storytelling strategies that relate to curriculum objectives
- Create/manage child-centered music and movement strategies that explore story concepts as they relate to curriculum objectives

Interviews

Teaching artists, when interviewed about their experiences in residencies, offered examples of topics they covered. For instance, artists described covering mathematics topics such as measurement, “part, part, whole,” and money, and art topics and strategies such as dance phrase or pattern, role play, music, story dramatization, coffee can theatre, and songs that reinforce concepts. Two teaching artists described pacing content more slowly for special needs students. For instance, one explained that her special needs class covered “shapes, prepositions, and patterning,” while general education classes got through more material.

Active Learning

In a national study of the Eisenhower Professional Development program, Garet et al. (2001) defined active learning as the opportunity for discussion, practice, and reflection; the opportunity to observe and be observed, to review student work with others, and to reflect, discuss, and write about learning.

In a number of studies building on the Eisenhower evaluation, researchers have delineated the following six elements of active learning as indicators: participants observe demonstrations of teaching techniques; participants practice and receive feedback; participants practiced using student materials; participants lead group discussions; participants conduct a demonstration of a lesson, unit, or skill; and participants review student work or score student assessments.

The evidence—the PD observations, residency planning forms, and artist interviews—indicates that the WT PD Institutes gave teachers the opportunity to engage in five of the six elements, and the residencies gave teachers the opportunity to engage in all six of the elements.

In table 4 and in this section, we note examples of how teachers were involved in active learning, beginning with the PD Institutes.

PD Institutes

Participants observed demonstrations of arts-based strategies and early childhood pedagogy practices. On the first day of each Institute, the performing artists demonstrated principles of their art, and asked teachers to be participants in their presentations. For example, a dance artist showed teachers, via movement, what “energy” and “space” mean in the concept of dance, and then gave teachers the opportunity to get up and experience energy and space for themselves.

Participants practiced what they were learning. Each day of the Institutes began with energizers, 15–20 minute warm up sessions led by teaching artists. The energizers brought teachers, guests, WT project staff, and artists together, signaled the start of activities, and gave teachers the opportunity to practice exercises that incorporated mathematics and arts and could be used as part of classroom lessons. For example, one energizer, called action stretching, asked teachers to imitate a pattern of body movements and use the vocabulary up, above, down, below, out, front, far, close, and so on. Further examples of practice were in experiences led by artists (based on lesson plans) in which teachers “acted the role” of students to learn from both the student and teacher perspectives.

Participants led group discussions. On days 2 and 3 of each Institute, teachers worked in small groups for brainstorming and discussion. These sessions began with questions like, “*What are you doing in Number Sense [or Geometry, etc.]? What could you do? What do you see children doing spontaneously?*” Each group was provided with an easel, paper, and marker to create brainstorm lists to share with the larger group afterwards. The activity gave participants opportunities to lead discussion in the small brainstorm groups, as well as in the larger group, as time permitted.

Participants conducted a demonstration of a lesson, unit, or skill. In the 2012 Institute, for the returning group 1 teachers, teachers (together with artists) led sample lessons from their first-year residencies.

Participants developed and practiced using student materials. During the Institutes, teachers had the opportunity to “use” student materials (shapes, scarves, puppets) as though they were the students, in all the arts/mathematics model lessons. They also used mathematics materials, such as dice, frames, and nonstandard measures. In one activity, they also visited different stations, where they had the opportunity to think about student materials (e.g., books, tangrams) and how to use them.

Participants reviewed student work or scored assessments: In the past 10 years it has become more common for workshops and professional learning communities in schools to use student work as a starting point for professional development conversations. The 2011 and 2012 Institutes did not focus on reviewing student work or analyzing student data, such as examples of student performance in arts-integrated classes. However, the lesson plans in binders did reflect a philosophy of differentiation and potential for extension and expansion of procedures based on student knowledge and skills. Also, in their Institute presentations, the teaching artists used language that indicated differentiation was important; the artists also articulated questions to help teachers assess students’ understanding of both mathematics and arts concepts.

Residencies

The teaching artist lesson plan analysis and the interviews confirm that teaching artists planned to continue to provide for teachers in their residencies opportunities for the active learning that started in the PD Institutes, and that the residencies additionally gave teachers the opportunity to review evidence of student understanding with the teaching artist coaches. The teaching artists used the residency and lesson plan approach (developed collaboratively with teachers in the Institutes and in planning sessions at school) to structure classroom activities and in so doing artists continued the use of assessment-oriented statements “I observe..” and assessment-type questions “What is another way we can find out..”. These prompts modeled real-time assessment of student understanding. In the debrief, teaching artists and teachers referred to the observations of student participation as a basis for refinement of activity development.

Seven of the seven forms in the lesson plan sample indicated that teachers would be actively learning and included an example of the gradual-release coaching cycle (plan, model, co-teach, debrief) as it applied to their specific residency. Specifically, each form had a place for teaching artists to note “teacher’s role to achieve the arts skill.” For instance, one form indicated:

Teacher’s role to achieve arts skill:

Movement Sequence:

- a. Teacher will observe and repeat segment of modeled movement sequence, focusing on contrast.
- b. Teacher will co-lead same movement sequence development process.
- c. Teacher will create and lead a lesson using the same movement sequence strategy in a new way.

Songs as Transitions / Creating New Songs

- a. Teacher will observe and participate in the process of creating a new song strategy to meet a defined transition objective, leading repetitions of the song, participate in assessing the song’s effectiveness, and participate in revisions.
- b. Teacher will take the lead in creating/adapting a transition song for a new purpose, co-lead it and participate in assessment and revision of the strategy.
- c. Independently, Teacher will create, lead, assess and revise a song strategy that meets a new transition objective.

Interviews

Interview evidence confirms this assessment regarding active engagement. In our interviews, all nine artists were asked about the strategies they used in their coaching, and whether they used a gradual release model.

All nine teaching artists interviewed indicated that “yes,” their coaching included the gradual release strategies (plan, model, co-teach, debrief). Comments from artists included “Yes, we did all that—I modeled, I co-taught, etcetera” and “I talk to teachers about what the teacher and student needs are and I try to work with teachers to create an art strategy that addresses those needs. Then I model the best practice [for delivering the arts-based mathematics teaching

strategies] and bring it to the teacher and then they do it [deliver the strategy]; I pass it to the teacher.”

Coherence

The term *coherence* refers to the extent to which the activities and goals involved in the PD are aligned with other initiatives designed to change instruction, including standards, assessments, and curriculum adoptions; the extent to which they are consistent with teachers’ personal goals for development; and the extent to which teachers have the opportunities to communicate with others involved in similar professional development activities (Cohen & Hill, 1998; Garet et al., 2001; Grant, Peterson & Shojgreen-Downer, 1996; Lieberman & McLaughlin, 1992). Professional development appears to be effective when all of these elements of coherence are exhibited (Garet et al., 2001).

In this report, we focus on coherence in just one specific sense: we consider the extent to which the WT PD Institutes and residencies were aligned with district standards and the mathematics pacing guides. The evidence suggests that the Wolf Trap PD program included attention to district mathematics standards in the preparation of teaching artists, in the PD Institutes, in the PD Institute binders, and in the residencies.

PD Institutes

In the preparation of teaching artists and on day 1 of the Institutes, a presenter from the Fairfax County Office for Children gave an overview of the National Council for Teachers of Mathematics (NCTM) content standards and recent theory regarding how young children learn mathematics. In the 2012 Institute, representatives of the district’s mathematics curriculum office discussed recent changes to the district content standards.

The PD Institute binders included the district’s seven early childhood mathematics content standards and program-of-studies documents for prekindergarten and kindergarten which included examples of activities that correspond to the standards.

For each content area, the binder included a definition of the benchmark for the standard, a note about the literature and research base, and indicators that a child is acquiring knowledge in the area of the benchmark.

For example, for the benchmark “probability and statistics,” the materials from the district in the binder noted:

Benchmark: Students begin to participate in the process of collecting data in order to answer questions of interest.

Literature/research base: Data analysis develops naturally from children’s sorting and classifying activities and their interests in comparing groups of objects. These early comparisons enable them to make rough estimates of which group has more and which group has less.⁹

⁹ The development of the Institute materials was informed by the work of educators such as Juanita Copley and Mary Baratta-Lorton.

Indicators:

- DSP 1: Sorts a group using one attribute (e.g., color, size, or shape)
- DSP 2: Participates in a discussion about the data to ask and answer questions (e.g., child notices which group has more, less, or the same amount of children.
- DSP 3: Participates in creating graphs using real objects (real graphs) which are of interest to children (e.g., students stand in groups by the types of shoes they wear)

The lessons that the teaching artists modeled for teachers were focused on the standards and benchmarks the teachers would be covering: number sense, geometry, measurement, data analysis and probability, and algebra. In each area, teaching artists demonstrated how to cover the topic through the art forms of music, drama, and dance.

The following table shows the lesson plans included in the binders for 2011, sorted by mathematics topic.

Table 7: Lesson Plans Included in the Summer Institute Participant Binder, 2011

Number and Number Sense	Geometry	Measurement	Data and Probability	Algebra
Mushroom in the Rain	Triangle Princess	Alorte and Kwakwe	Three Bears	Animal Band
Balance	Caps for Sale	Quillworker	The Mitten (drama, dance)	We Are All Going on Safari
Part Part Whole	Curvy and Pointy	Too Much Noise	Animal Band (Crows in the Kitchen)	Car Patterns, I and II
Dancing Names	Sphere and Cube	Gorilla, Gorilla With Dance	Sorting	High and Low Patterns
Zero	Shape Singing	Measuring Time		A/B Patterns
Greeting Song	Circle of Song	Pumpkin Sizes		Change Time
Lineup		In and Out of the Pond		Growth Pattern
Rooster's Off		Exploring Heavy and Light		Too Many Fairies
		Loud and Quiet Singing		
		Gorilla, Gorilla With Music		

The lesson plans included in the summer 2012 participant binder were nearly identical in topic. Binders for returning group 1 teachers included additional plans (energizers, or other lesson activities). Examples include: Graphing Character Movement (based on a selection of animal characters and how they move); Spots (recognizing simple patterns and body shapes); Action Stretching (pantomime and pattern); Count 'Em Now (counting numbers and music elements);

Tens Frame (exploring number combinations through movement on a tens frame); and Change Travel (counting items; moving forward and back; counting pennies, nickels, and dimes).

Residencies

The analysis of the artists' lesson plans confirms that teaching artists planned to continue the focus on consistency with district standards, working collaboratively with the teachers.

Seven of seven artist planning forms we examined indicated that district curriculum topics would be covered. In four of the seven forms, the artists checked off the mathematics and arts concepts within the lists of district curriculum topics that would be covered in the residencies; three of the seven forms conveyed the information elsewhere in the form. Mathematics topics checked off in the forms we sampled include, for example, Number and Operations, Counting, One to One Correspondence, Recognizing Numerals, Quantity, and Comparisons.

Interviews

In our interviews, all nine teaching artists were asked the extent to which they ensured lessons were consistent with district standards, and about which standards they focused on. All nine confirmed that they did match lessons with district standards.

Examples include counting, number sense, shapes, and prepositions. For example, one teaching artist explained:

Right on my desk I have the book of Fairfax standards. Teachers know what their standards are. As we would introduce each section I would ask them what standard we're working on. They're in our residency plan too so when we began each session I would ask them what we're working on over the time.

In addition, artists noted their practice of developing lessons and procedures based on the concepts or topics the teacher identified as fitting into the classroom curriculum and for which teachers requested support.

Part III. Fidelity

In this section we report on *fidelity*—the extent to which the WT PD Institutes and residencies were implemented as designed; that is, the extent to which they delivered preparation to classroom teachers to infuse arts-based strategies into their mathematics instruction.

The first step in the investigation of fidelity was to specify the WT model and clearly define each component so that it could be observed (i.e., the specific performing arts strategies to be conveyed in artist demonstrations; the early childhood pedagogy strategies mentioned or modeled; and the mathematics concepts and operations to be covered). With this understanding we planned to document whether these components were present or absent in the WT PD and document variations that occurred, especially those variations with the potential to affect the fidelity of implementation.

The evidence (PD observation, lesson plans, artist interviews) indicates that the WT PD program (PD Institutes and residencies) did deliver preparation to teachers to integrate arts-based strategies into their mathematics instruction and that this implementation was consistent in terms of the approach across schools and teachers. The agendas were followed as designed. Activities were implemented as planned. The Institutes introduced arts content, mathematics content, and arts-based strategies. Teachers practiced, received feedback, and engaged in discussion with their coaches (artists) and their peers. Teachers and artists engaged in planning for residencies. All the materials used in Institutes reflected materials planned and used in the residencies.

Teaching artists modeled their approaches in the Institutes and then implemented those approaches in residencies. The residency and lesson plans provided with Institute materials and then adapted for classrooms contained a structure reflecting the content and approach introduced in the Institutes. This consistency of structure and content was intended to support fidelity of implementation.

PD Institutes

As noted in Table 4, the majority of the time at the PD Institutes focused on training classroom teachers to infuse performing arts strategies into mathematics instruction. The PD followed the agenda as planned and the theme of arts integration with mathematics was infused throughout Institute activities. These two examples illustrate the approach to integration used by artists.

Drama and Number/Number Sense: Mushroom in the Rain

In this activity, the teaching artist created a multi-dimensional presentation based on the book *Mushroom in the Rain*.¹⁰ The artist wove several components of drama (i.e., character development, plot) together with concepts of number, number recognition, spatial recognition, and mathematics vocabulary, linking arts and mathematics. For instance, as the teaching artist told a story, she illustrated the story on a white board with words and pictures. The words were placed in the correct spatial relation to one another. For instance, the word “sun” was at the top of the page, and the word “mushroom” was in the middle. Students would be asked where to put

¹⁰ *Mushroom in the Rain* is written by Mirra Ginsburg and illustrated by Jose Aruego.

the words, the presenter explained, as well as whether they were “under” or “over” each other—mathematics vocabulary. She modeled this for teachers, showing how when she added “mushrooms” to the whiteboard, she would also ask students to count them (mathematics concept). As she modeled, she used different voices while acting like different animals in the story—for instance, she used a mouse voice to say “please,” using a different pitch to create character.

Dance and Geometry: Introducing 3-D shapes

In this activity, the teaching artist presenter used a puppet as the “leader” and asked the teachers (who were acting as students) to mimic the dance moves of the puppet. The teaching artist had the puppet dance in “pointy” (elbow) or “curvy” shapes (make arms into a “C”), prompting students to create angular shapes within their body, thus doing both mathematics (geometry) and dance (movement). The presenter then put objects on the ground, and asked students (the teachers) to do a curvy dance shape near a curvy visual shape on the ground. The teaching artist also discussed different types of cues, explaining that she could cue students using different senses: she could show curvy shapes (sight), say “pointy” or “curvy” (sound), or have students feel pointy or curvy shapes in a bag (touch). She explained that teachers can know whether students understand the concept of pointy and curvy by teaching it one way (e.g., via movement) and seeing if students understand it in another context (e.g., on paper).

Residencies

In the residencies the planning and lesson forms were expected to reflect this approach to arts integration. We found evidence of this in the procedures which spelled out the activities, the vocabulary, the objectives, and the expectations for students.

Lesson Planning Forms

The analysis of the lesson plan forms confirms that the teachers and teaching artists planned to link arts with mathematics in the lessons designed for students. It was evident from reading the lesson plans that the content and the practices therein were building on the presentations artists had given in the PD Institutes and examples they had discussed with teachers in small groups during the Institutes.

All 20 of the lesson plan forms we sampled indicated that the lesson would link arts and mathematics, that is, use an arts skill to teach a mathematics concept or vice versa.

For instance, one lesson plan indicated that the instructor(s) would teach counting and adding (mathematics) through locomotor and non-locomotor movement (dance). Another lesson plan indicated that the instructor(s) would teach number recognition and counting (mathematics) while acting out a story with animals and costumes (drama).

Interviews

All nine teaching artists confirmed that they modeled and practiced with classroom teachers the strategies to integrate arts into mathematics instruction that were introduced in the Institute.

Teaching artists reported that the activities and content in the Institute was important preparation for implementation of arts strategies; seven of nine artists indicated that institute helped teachers

to a great extent. Artists also reported that the work in classrooms during residencies was key to implementation. In one artist's opinion "the institute gave a start but teachers did not really see "it" until they were in the classroom". For instance, one artist explained that she worked to train the teacher to integrate mathematics into the language of songs, and the narrative of stories, such as *The Snowy Day*; *Too Much Noise*; and *Brown Bear, Brown Bear, What Do You See?*¹¹

Artists perceived that many teachers understood and were able to implement the arts-integrated approach. One commented that "teachers were able to teach the arts topics modeled." Artists also noted that teachers already "had early childhood pedagogy as background" and one artist noted that adding the arts "helps them expand their ability to address and differentiate and create multi-sensory experiences."

The interviews with teaching artists highlighted the collaborative nature of PD which WT believes is essential to successful implementation of new practices. Teaching artists commented that they developed the objectives and procedures for arts integration with teachers and based their work on what teachers said was needed to help students be successful in mathematics study. The collaborative nature of the residency indicated that strategies and content were reflective of instructional and curricular needs; it also meant that some adaptations in implementation were made, for example, some artists planned with all teachers together; others planned with individual teachers. In addition, artists working with teachers of special needs classes adapted songs and movement to meet the abilities of the students in the classroom.

¹¹ *The Snowy Day* is written by Ezra Jack Keats. *Too Much Noise* is written by Ann McGovern and Simms Taback. *Brown Bear, Brown Bear, What Do You See?* is written by Bill Martin, Jr., and Eric Carle.

Part IV. Summary and Conclusion

In this section, we summarize our key findings, and then we extend this and conclude by discussing some of the strengths and challenges associated with the implementation of the WT PD approach.

Key Findings

RQ1: To what extent does the Wolf Trap PD represent six features of high quality professional development? These features include form, duration, collective participation, content, active learning, and coherence (Garet et al., 2001).

The evidence—including the PD Institute observations and materials, residency planning forms and lesson plans, and artist interviews—indicates the following.

- **Form:** WT and the teaching artists delivered PD that included training for artists, a summer PD Institute, and coaching, all of which were characterized by active and “reform” orientations to PD, as compared to traditional PD sessions (Garet et al., 2001).
- **Duration:** The WT PD program included 101 hours of PD per teacher over two years, slightly exceeding the 49 hours per year found to be effective in recent research (Yoon, 2007). Some teachers left the study at various points and others remained in the study but did not participate in all activities, therefore all did not receive the same “dose” of PD.
- **Collective Participation:** WT sought to facilitate collective participation by opening recruitment to all prekindergarten and kindergarten teachers at each participating school. In some treatment schools all eligible teachers participated together. However, in others, teacher attrition and interest affected collective participation.
- **Content:** Teachers are expected to come to the WT PD program with expertise in early childhood mathematics instruction and early childhood pedagogy from their education and classroom experience. The WT PD program primarily covered how to integrate arts-based strategies into mathematics instruction, and to a lesser extent, it covered what students were expected to know in mathematics, as well as early childhood pedagogy strategies teachers could use to instruct students.
- **Active Learning:** The PD Institutes gave teachers the opportunity to engage in five of the six elements of active learning: teachers observed demonstrations, practiced what they learned and received feedback, led group discussions, conducted a demonstration (of a lesson, unit, or skills), and developed and practiced using student materials. The residencies gave teachers the opportunity to engage in all six elements—the five mentioned above, plus reviewing student work or scoring assessments. In the residencies, artists reported working with teachers to identify where students were having difficulties in their classroom, and how to use arts-based strategies to facilitate progress. In contrast, the Institutes included minimal (if any) discussion of student performance generally, or of “real life” work of prekindergarten and kindergarten students, except in small group discussions when teachers described what they were currently teaching. One caveat to this discussion is the afore mentioned articulation of questions for the purpose of quick assessment of student knowledge and the recommendation that teachers use multiple

modes through which to assess student knowledge. Both of these assessment strategies were mentioned in presentations during the Institute and were an explicit component of the teaching artist lesson plan.

- **Coherence:** The WT PD delivered to teachers aimed to be consistent with district mathematics standards for early childhood, and included attention to these standards in the PD, in the PD binders, in presentations during the Institutes, and in planning and implementing the residencies. The lesson plans specified the standards and artists noted these were checked with teachers in planning and debriefing.

RQ2: Is the Wolf Trap PD implemented with fidelity? That is, does the WT PD program (summer PD Institutes and residencies) deliver preparation to classroom teachers to infuse performing arts-based strategies into their mathematics instruction, as intended?

As evidenced by the PD observations, residency plans and lesson plans, and artist interviews, the WT PD program did deliver preparation to teachers to infuse arts-based strategies into their mathematics instruction, starting in the PD Institutes and then continuing in the residencies. The Institutes followed the agenda as planned; the residencies followed the coaching cycle as planned; and the lesson plans were used to meet goals of content coverage, instruction and arts integration. WT used several approaches to optimize fidelity: a planning year and practice sessions with teaching artists; consistent use of local content experts; and materials structured to reflect the concepts and approaches used in both Institutes and residencies. While many of the lesson plans in the PD Institute binder were revised later for classroom use, as per the teaching artist collaborative work with teachers, the structure remained the same.

Overall, WT and the teaching artists delivered PD that exhibited the six features of high quality PD, qualified by the consideration that not all teachers from each school participated and not all recruited teachers participated for the entirety of the program. The PD was implemented with fidelity, and it delivered preparation to classroom teachers to integrate arts-based strategies into their mathematics instruction.

To extend the discussion presented in this report, we would like to add that our review revealed additional strengths and challenges associated with the WT PD implementation. We present these as a way to assist WT in building on program strengths and addressing program challenges. Our considerations in this area are consistent with other researchers' discussions of PD initiatives, which note that factors outside of a planned intervention may influence the quality and fidelity of implementation (Durlak & DuPre, 2008), and that institutional, school, and community level elements—such as districts' arts standards, current PD for teachers, and schools' prior experience with arts—are important for arts integration initiatives (Rabkin & Redmond, 2004).

Strengths

Capacity

Wolf Trap has a strong roster of performing artists conducting residency work with early childhood teachers. The WT organization has a long-standing relationship with most of the artists who worked with teachers for this program. Nearly all of the artists working in this project

have been in schools for many years (artists had from 3 to more than 30 years of experience) and have established routines for working with teachers as a teaching artist. The teaching artists understood the goals of the AEMDD project because of their prior experience serving as artists with WT. Also, WT provided teaching artists with detailed information about the goals and design of the program during their initial PD and on a continuing basis. WT's capacity benefitted from WT's relationship with the Fairfax County Office for Children and its representative, Maria Gallagher; along with education specialists from Fairfax County Public Schools (FCPS), including kindergarten, mathematics, and special needs specialists. With the participation of specialists, WT prepared and presented content in the planning year and for the Institutes. Ms. Gallagher and specialists from FCPS participated in the summer PD Institutes, where they served as resources for teaching artists and teachers, who already had education and experience in early childhood instruction.

Partnership With the District

The partnership with the partner district contributed to successful implementation. The district research office provided guidance in submitting the required application to conduct the evaluation. District administrators actively supported dissemination and recruitment of schools. The district early childhood administrators and content experts provided guidance and materials related to mathematics topics and sent district STEM coordinators to Institutes and advisory meetings. Language specialists from the district translated letters to parents about student participation in the study. The research office for the district provided information needed for the selection of students and used procedures to safeguard student identity.

Experience and Relationships

WT's historical and continuing work in early childhood classrooms throughout the Washington–Maryland–Virginia region was essential in locating classrooms to pilot mathematics lessons in the planning year and to disseminate the products of the AEMDD grant. As part of the grant, WT disseminated the PD model to all of its 16 regional affiliates, holding a summer PD Institute for the affiliate representatives.

Continuous Improvement Culture

WT incorporated improvement-focused activities throughout the implementation years of the grant. WT held meetings for teachers and teaching artists, maintained communication with district content experts, and sought feedback from an advisory group. As a result of these efforts, WT was able to revise the content and the format of the Institutes in ways that mattered to teachers and artists. For example, after the first PD Institute, WT gave teaching artists feedback that demonstrations would be improved if they were clearer about their objectives. For the second PD Institute, the artists were explicit about the mathematics and arts objectives for each demonstration, and in some demonstrations, artists provided interpretive commentary to help teachers process the content. Additionally, teaching artists and teachers shared with WT that kindergarten mathematics was more rigorous than expected and that refinement in some existing lesson plans would strengthen their applicability for the needs of teachers and students. In response, WT delivered additional content to the teaching artists and guidance regarding the plans.

Preparation of Teaching Artists

In our interviews, teaching artists who worked with group 1 teachers described the benefits of the planning year, and the planning for summer PD Institutes and residencies. Artists noted that the WT team asked presenters to rehearse experiences before demonstrating for a large group—a level of rigor that improved the quality of the presentation. Teaching artists adapted Wolf Trap strategies to meet varying student needs, which sometimes helped students’ progress in unexpected ways. For instance, one teaching artist recounted the experience of her teacher when on a home visit to a student from her class:

During this home visit, the student’s parent told the teacher that the student took a baby wipes container and turned it over and pretended it was a drum! As a result of being exposed to a drum in the classroom, the student visualized the wipes container as a drum, an unexpected conceptual leap.

The artist reported that this experience was rewarding for the family as well as the teacher.

Recommendations

Based on the review of data sources and reflections on the features of high quality PD, a few recommendations emerged that could inform continuing development of PD and delivery:

1. **The training for the residencies and the PD Institutes could incorporate observations of in-session classrooms (e.g., summer school).** This would give teachers and teaching artists the opportunity to discuss students’ work and their “real” live interactions (active learning). Teaching artists commented that teachers were “missing” from the planning year and that they would have preferred observing in classrooms to identify teacher practices before or while preparing their own lessons and residency plans.
2. **WT could invite additional experts to work with the artists to prepare them for the student populations they will work with, particularly special needs students and kindergarten students.** The WT PD did include an introduction to research on mathematics learning; however, this may not have been of sufficient depth to prepare all artists for linking mathematics and arts concepts for all students.
3. **WT could strengthen the early childhood pedagogy component of the PD by including it more explicitly.** For instance, WT could include in the binders a list of the pedagogy components (e.g., intentional questions) that were on whiteboards during the PD Institutes, with definitions and examples of how to use them. These components were named and presented in the Institutes to some extent, and they were included in WT documentation. WT could strengthen the coverage of this content by specifying these strategies and their research base, being explicit about the use of strategies, and offering practice and feedback on their use during the PD Institutes.

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Appendix A. Analysis Procedures by Data Source

Analysis Procedures by Data Source

To gather information about the PD Institutes, the AIR team observed each Institute, reviewed observation forms, and reviewed materials in the WT binders. To gather information about the classroom residencies, the AIR team reviewed teaching artist residency planning forms, lesson plan forms, and interview data. This appendix details our analysis procedures for each. Please note that some data collected in these qualitative analyses may be used for a later final report.

PD Institute Materials: Qualitative Analyses

Residency Materials – Teaching Artist Residency Planning Forms: Qualitative Analyses

<p>Data Sources</p>	<p>The AIR team used the teaching artist residency planning form rubric (available here: http://www.wolftrap.org/~media/files/pdf/education/blank_residency_planning_form_analysis_spreadsheet.ashx) to review a sample of seven teacher residency planning forms, selected out of the larger group of residency planning forms. A sample teacher residency planning form is available here: http://www.wolftrap.org/~media/files/pdf/education/Planning_Form.ashx</p> <p>The AIR team purposefully selected the sample so that it included forms from a variety of teaching artist-teacher teams. The AIR team reviewed the forms for the following elements: content (RQ1), active learning (RQ1), and coherence (RQ1).</p>
<p>Qualitative Analysis Procedures</p>	<p>Two analysts reviewed each teaching artist residency planning form for each of the three elements above, and summarized the extent to which the residency was planned to address each element. The analysts recorded their responses in the teaching artist residency planning form rubric. For each element, two analysts then reviewed the responses for the sample overall. In cases of disagreement, the two analysts reviewed data together to resolve them.</p>

Residency Materials – Teaching Artist Lesson Plan Forms: Qualitative Analyses

<p>Data Sources</p>	<p>The AIR team used the lesson plan rubric (available here: http://www.wolftrap.org/~media/files/pdf/education/blank_lesson_plan_analysis_spreadsheet.ashx) to review a sample of 20 lesson plans, selected out of the larger group of lesson plans. A sample teacher residency planning form is available here: http://www.wolftrap.org/~media/files/pdf/education/Planning_Form.ashx. The AIR team purposefully selected the sample so that it included forms from a variety of teachers, but within the groups of forms for each teacher, documents were chosen randomly. The AIR team reviewed the forms for fidelity (RQ2).</p>
<p>Qualitative Analysis Procedures</p>	<p>Two analysts reviewed each lesson plan, checking for evidence that the lesson would link arts and mathematics. Two analysts then reviewed the responses for the sample overall. In cases of disagreement, the two analysts reviewed data together to resolve them.</p>

Residency Materials – Teaching Artist Interviews: Qualitative Analyses

<p>Data Sources</p>	<p>The AIR team interviewed the nine teaching artists working with the first group of treatment teachers in 2011–13, using the protocol (available here http://www.wolftrap.org/~media/files/pdf/education/Interview_protocol.ashx) to gather information on the following elements: content (RQ1), active learning (RQ1), coherence (RQ1), and fidelity (RQ2). The interviews were conducted via phone.</p>
<p>Qualitative Analysis Procedures</p>	<p>Two analysts were on the call for each interview: one analyst asked questions, and the other took notes. After each interview, an analyst reviewed the interview recording, and revised the notes such that they were near-verbatim quality. Next, an analyst compiled the interview responses of different teaching artists into one spreadsheet, organized by question topic. Finally, two analysts reviewed the group of responses for each topic, across artists. The AIR team focused on the following questions, to address the elements above:</p> <p>Content:</p> <ul style="list-style-type: none"> - What content—which mathematics topics and which arts components—did you cover in the residencies? - Was there a mathematics content area that was a more frequent focus of your residencies? Did you cover all the mathematics topics in the curriculum for the year, or just a subset of selected topics? (If the latter, how were the topics selected and how many topics were covered?) Feel free to refer us to a specific lesson plan or residency form you used; we’d be happy to look it up in the binders. <p>Active Learning:</p> <ul style="list-style-type: none"> - What strategies did you use to teach this content? - Did your coaching include modeling, or co-teaching, or joint-planning, or observing/giving feedback, or discussing students’ work? Please describe. - To what extent did the coaching give teachers the opportunity to engage in active learning? “Active learning” means engaging teachers through meaningful discussion, practice, and reflection. (please rate each to a great extent, to some extent, or not at all) <p>Teachers appear to benefit through:</p> <ul style="list-style-type: none"> o Opportunities to observe and be observed by expert teachers o Opportunities to integrate learning into classroom practice o Opportunities to review student work with others o Opportunities to reflect, discuss, and write about their learning <ul style="list-style-type: none"> - And could you give an example? <p>Coherence:</p> <ul style="list-style-type: none"> - To what extent were you able to ensure lessons were consistent with district standards? - Which district standards did the teachers focus on? Which lessons or strategies were most coherent with the district standards or the pacing guide? <p>Fidelity:</p> <ul style="list-style-type: none"> - Could you reflect on how your coaching helped teachers link arts and mathematics? (Please rate: not at all, to some extent, or to a great extent) - What was the most important type of preparation for you as you took on the role of the teaching artist in this study? Could you rank these in order of importance to you?

	<ul style="list-style-type: none"> ○ The planning year? ○ The institute in the summer? ○ The scheduled meetings? ○ The residency and work with WT staff? ○ Other? <ul style="list-style-type: none"> - Why were these important—what did they contribute to your feeling of being prepared? - How important were the lesson plans you developed for the institute binders? To what extent did you work with them when you began the residencies? <ul style="list-style-type: none"> ○ Did you base the residency lessons on the lesson plans in the binders? ○ Did you modify them? Or create new ones? How and why? ○ Did you make any changes in your work (approach, content of coaching) with cohort two teachers, based on your experience with cohort one teachers? - Would you reflect on how the WT PD institute helped teachers (please rate each not at all, to some extent, to a great extent) <ul style="list-style-type: none"> ○ Link arts and mathematics ○ Teach mathematics and arts topics ○ Use research-based early childhood pedagogy strategies <p>And could you give an example of each?</p> - Could you reflect on how your coaching helped teachers: (please rate each: not at all, to some extent, to a great extent) <ul style="list-style-type: none"> ○ Link arts and mathematics ○ Teach mathematics and arts topics ○ Use research-based early childhood pedagogy strategies <p>And could you give an example of each?</p>
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