



Arts Integration: A Promising Approach to Improving Early Learning

Meredith Ludwig
Mary Beth Marklein
Mengli Song

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1000 Thomas Jefferson Street NW
Washington, DC 20007-3835
202.403.5000

www.air.org

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Study Design

American Institutes for Research's (AIR's) study of Wolf Trap's Early STEM/Arts program was a randomized controlled trial: 22 public elementary schools in two cohorts were randomly assigned to participate in the Wolf Trap program or continue their usual practice, and 18 of those schools, all Fairfax County Public Schools in Northern Virginia, participated in the study. The first cohort included 38 teachers from six schools; the second cohort included 42 teachers from 12 schools. The student sample included approximately eight students randomly selected at the beginning of the study from each participating teacher's classroom.

[Wolf Trap Foundation for the Performing Arts](#)

Institute for Early Learning Through the Arts offers professional development (PD) to early childhood teachers built on the philosophy that dance, music, and drama can help young children master skills across a range of subjects. Research has found that this approach, termed arts integration, has great potential for improving student learning in multiple disciplines (Burnaford, 2007; Goff & Ludwig, 2013; Rabkin & Redmond, 2004).

A study by Klayman (2006) showed that using performing arts strategies in classroom content instruction, employing the approach developed by the Wolf Trap Institute, has the potential to improve students' language and literacy skills.

That study found also that students whose teachers participated in Wolf Trap's PD program demonstrated higher levels of skill in initiative, social relations, creative representation, music, movement, logic, and mathematics than students whose teachers had not participated.

Klayman's (2006) findings, along with research suggesting that a student's mastery of early mathematics skills is a strong predictor of later academic success (Duncan et al., 2007), led Wolf Trap to add mathematics education to its suite of PD programs for teachers of young children.

In 2010, Wolf Trap Foundation received a \$1.15 million grant from the U.S. Department of Education's Arts in Education Model Development and Dissemination Program (AEMDD) to develop a program that would apply Wolf Trap's PD approach to science, technology, engineering, and mathematics (STEM), with a focus on mathematics. The Early Childhood STEM Learning Through the Arts (Early STEM/Arts) program was the subject of a four-year study conducted by American Institutes for Research (AIR) in partnership with Fairfax County Public Schools in Virginia.

This brief summarizes the findings from the three reports that were produced as a result of the AEMDD grant, providing additional insights into the outcomes from Wolf Trap's Early STEM/Arts program (Goff & Ludwig, 2013; Ludwig & Goff, 2013; Ludwig & Song, 2015).

The AIR study found that Wolf Trap's Early STEM/Arts program had a significant positive impact on the participating teachers as well as their prekindergarten and kindergarten students. Compared with teachers who did not participate in Wolf Trap's training and related activities, participating teachers were more likely to use the performing arts as part of their classroom mathematics instruction. Their students earned significantly higher scores on a standardized mathematics test (i.e., the Early Math Diagnostic Assessment; see Pearson Clinical, 2003) than their counterparts taught by nonparticipating teachers in both the first and second years of

program implementation, even though not all students in the second year continued in classrooms with teachers participating in the program.

The first-year impact is equivalent to 1.3 additional months, or 26 additional days, of learning for students whose teachers had participated in the program. The second year impact amounts to 1.7 additional months, or 34 additional days, of learning. Although AIR's study had limitations (e.g., small sample size and substantial attrition of study participants), it provided promising evidence for the positive impact of the Wolf Trap program on students' mathematics achievement.

These findings compare favorably with findings about some of the other early childhood strategies for mathematics achievement, as reviewed by the U.S. Department of Education's What Works Clearinghouse (WWC). The AEMDD evaluators also found that rigorous research on strategies for introducing young children to mathematics concepts is limited, even as both early childhood learning and STEM education have emerged as [national priorities](#) established by the U.S. Department of Education.

Before assessing the impact of Early STEM/Arts, AIR analyzed the implementation of key features of the program based on a framework for examining the quality features of PD (Garet, Porter, Desimone, Birman, & Yoon, 2001).

The PD approach implemented as part of the Early STEM/Arts program incorporates PD workshops for artists and teachers prior to the school year. PD is provided for teachers through artist modeling and coaching in what are termed *classroom residencies* during the school year.

Findings About Early STEM/Arts Compared With Findings About Other Early Childhood Interventions Reviewed by the What Works Clearinghouse

The impact of the Wolf Trap program compares favorably with the impact of some of the other early childhood interventions on mathematics achievement. The Head Start Impact Study (U.S. Department of Health and Human Services, Administration for Children and Families, 2010), for example, found no significant impact on any of five measures of mathematics skills for four-year olds in any of the three years examined, and a significant impact on only one of four measures for three-year olds in one of the four years examined. That significant impact had an effect size—a standardized measure of the magnitude of impact—of .15. In comparison, the impact of the Wolf Trap program had an effect size of .17 in the first year and .21 in the second year, which translates to 26 and 34 additional days of learning, respectively.

Findings about the impact of other early childhood interventions reviewed by the What Works Clearinghouse (WWC), established by the U.S. Department of Education in 2002 as a central source of scientific evidence for what works in education, provide further context for interpreting the Wolf Trap program's impact.

Of the more than 80 early childhood interventions identified by the WWC (not including the Wolf Trap program), only five interventions other than Head Start had at least one study (six studies in total) that met WWC's evidence standard and that examined mathematics outcomes. Of those studies, two had a large significant positive effect on children's mathematics achievement (with effect sizes of .50 and 1.07), two had smaller nonsignificant effects (with effect sizes of .17 and .19) similar in size to the effects of the Wolf Trap program, and one had a much smaller and nonsignificant effect (with an effect size of .04).

Note. The impact of the early childhood interventions reviewed by the WWC may not be directly comparable with the impact of the Wolf Trap program because the studies differed in the sample, setting, and mathematics achievement measures used.

To qualify as a teaching artist, Wolf Trap required individuals to have at least three years of experience as professional performing or teaching artists and to undergo Wolf Trap training through workshops and in classrooms alongside mentors who were themselves teaching artists. During the course of a school year, teaching artists partnered with teachers in the classroom, and together these pairs developed teaching strategies that linked dance, music, and drama with early childhood mathematics concepts and skills. In Early STEM/Arts, both artists and teachers are

Findings on Implementation of the STEM/Arts PD

In its implementation study, which focused on the first cohort of teachers participating in the Early STEM/Arts PD program, AIR found that the program demonstrated key features of effective PD. As summarized in an article about the AEMDD grant, “[Wolf Trap’s PD] is classroom-based, intensive, and focused on what teachers and students need to know to teach and learn mathematics. It is aligned with district standards and offers many opportunities to teachers for active learning. The Wolf Trap PD program delivered preparation to teachers to infuse performing arts-based strategies into their mathematics instruction, starting in the PD institutes and then continuing in the residencies and did so with fidelity to the planned model. Wolf Trap 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” (Ludwig et al., 2014, abstract).

immersed in learning about how students learn academic content and about the arts-integration strategies that support teaching the content in the classroom.

For the AEMDD grant, the Early STEM/Arts PD consisted of the following:

- Ten of Wolf Trap’s professional teaching artists participated in intensive PD on early childhood mathematics.
- Wolf Trap developed and implemented intensive content and arts-focused PD for summer trainings in which teachers learned arts-integration strategies and planned with teaching artists, developing the framework for lesson plans to be used in classrooms during the school year.
- During the school year, artists modeled and coached teachers, continuing the Early STEM/Arts approach.

Teachers who participated in the program two full years received a total of 101 hours of PD focused on linking performing arts strategies with teaching mathematics. Classroom residencies with teaching artists consisted of

48 hours over the two years. Details about each aspect of the Early STEM/Arts PD as used in the AEMDD grant program are provided in the implementation report (Ludwig & Goff, 2013).

In the classroom residency, as teachers partner with professional teaching artists and work with students during their regularly scheduled classes, the artist’s modeling and coaching are facilitated through lesson planning. Example lessons are included in the materials developed by Wolf Trap and used in the summer workshops with teachers. During the school-year residencies, the goal is for teachers and teaching artists to develop and customize lessons based on the needs and goals of a particular classroom, the unique qualities of a particular art form, and the particular knowledge that each teacher brings to the project.

For the AEMDD-funded program, the Wolf Trap-trained teaching artists aligned several existing performing arts strategies, such as role-playing and choreography, to address the curriculum goals and standards outlined by the Fairfax County Public Schools. These performing arts strategies were also informed by the National Council of Teachers of Mathematics (NCTM) standards and research on mathematics learning by Copely (2010) and others. Two examples of lesson plans (*Bag of Dances* and *Mushroom in the Rain*) provide insights into how those strategies addressed both mathematics instruction and student needs.

Bag of Dances is a mathematics-oriented lesson plan in which the teaching artist (and later, the classroom teacher) introduces children to a series of objects (such as an elastic band, a feather, a spinning top, and a bouncing ball) that inspire movement. This example focuses on simple choreography (dance) to develop skills in patterning, which is the basis for algebraic thinking, and in data analysis, which builds problem-solving and reasoning abilities (Copely, 2010).

The lesson plan calls for students in small groups to examine four objects (top, ball, elastic band, and feather). Each child picks up the items and studies how they move, and then members of each group collaborate to create corresponding movements with their bodies.

Each group selects objects to represent a core pattern. A simple example would be “top, elastic band, top, elastic band,” which the teacher might identify as an ABAB pattern. A more complex example would be “ball, top, elastic band, ball, ball, top, elastic band, ball,” or an ABCAABCA pattern. As a group, the students dance the sequence of movements they have created, such as, in the second example, “bounce, spin, stretch, bounce, bounce, spin, stretch, bounce.” Understanding patterns helps students see relationships between numbers and symbols, between facts and procedures, and between mathematics and their daily lives. It also helps them learn how to predict what will happen next in a specific pattern (Copely, 2010).

For a lesson on data analysis using *Bag of Dances*, each small group takes a turn performing the sequence of movements it created, while the rest of the class records which items were selected. This information is compiled and displayed on a bar graph, allowing the teacher to ask questions such as which items were selected the most or least. These skills introduce children to mathematics concepts such as data collection, probability, comparisons, and descriptions (Copely, 2010).

Mushroom in the Rain is based on Mirra Ginsburg’s book, *Mushroom in the Rain* (Simon & Schuster, 1997). The story begins with an ant who gets caught in the rain and uses a tiny mushroom as an umbrella. One by one, the ant is joined by a series of characters, including a butterfly, a mouse, a sparrow, and a rabbit, each seeking shelter under the same mushroom. Each time, the ant thinks there is not enough room, but somehow they all squeeze in. By the end of the story, the ant sees that the rain caused the mushroom to expand, making room for more animals.

The lesson plan for *Mushroom in the Rain* employs a strategy called Coffee Can or Story Box Theater, which was developed by Wolf Trap teaching artists. Built around the dramatic arts and storytelling, it invites students to make connections between the imaginary and the concrete. The story introduces mathematics concepts such as directions, distance, and location, all of which are related to spatial thinking skills (Copely, 2010).

Lessons From the Classroom: The Teachers' Perspective

Kristin McClure, a teacher at Centre Ridge Elementary School in Centreville, Virginia, works with a mixture of kindergarteners and first graders, many of whom come from households in which Spanish, Vietnamese, or another language is the primary spoken language. By the end of the school year, her students are expected to have a solid foundation in mathematics concepts such as addition and subtraction. She and teaching artist Laura Schandelmeier, a dancer and choreographer, developed a lesson that begins with a series of movements, described as pathways, such as “zig zag,” “straight,” and “curvy,” which dancers might use. Then, still in the classroom, the children became dancers, responding accordingly as their classmates took turns directing performers, in groups of varying sizes, on which pathways they should use to enter and exit an imaginary stage.

Later, the students were asked to write a mathematics story problem based on the experience and to incorporate symbols such as plus and minus. One student's entry: “4 dancers were dancing in a zig zag slow low pathway. Then 7 more dancers entered the stage ... How many dancers are on the stage now? $4 + 7 = 11$.” These exercises help students make associations among symbols, numbers, and meaning, and they develop counting strategies to find sums and differences (Copely, 2010).

McClure has found that children are applying their new terminology in homework assignments and in their conversations among themselves. Videos and photos posted on a school website and weekly newsletters helped parents understand what the children had created. McClure later said several parents used the arts strategies at home with their children.

At Halley Elementary School in Fairfax Station, Virginia, special education teacher Laurie Yeager works with students who collectively have a variety of disabilities, including Down syndrome and autism spectrum disorder. Yeager's job is to orchestrate the day's activities so that every child meets his or her individual goals. She was paired with Kofi Dennis, a drummer and storyteller from Ghana. One of the first challenges she brought up with Dennis was motivating her students to transition from one activity to the next, particularly if they are enjoying the activity that is ending.

He introduced a call-and-response chant, *Agoo! Amee!*, which means, roughly, *Listen!* and *You have my attention!* The chanting is buttressed by the steady beat of a *djembe* drum, a beat that can incorporate musical elements such as dynamics (loud or quiet) and tempo (fast or slow), which correspond to the early childhood mathematics concept of measurement. The steady beat not only helps children understand mathematics and music fundamentals, but also it supports literacy skills (particularly the ability to speak and read with a smooth cadence) and social and emotional development (specifically, ways to focus, control impulses, and engage as a group). It also addresses one-to-one correspondence, a mathematics concept that requires students to link a single number with a particular object or movement, such as clapping along with the teacher's drumbeat (Copely, 2010).

Now, when it is time for students to shift gears, Yeager taps on a *djembe* drum, like Dennis's that she bought after her residency. The drumming gently signals students to wrap up what they're doing and prepare for the next activity.

The teacher begins by asking students to visualize a box full of props, and then the teacher introduces vocabulary, such as characters, settings, and the notion of “cue.” As the children begin to see the story in their minds, they use positional words (“under,” “over,” and “beside”), build skills in sequencing and ordinal numbers (first, second, and third), and learn vocabulary such as “symmetry” (the six legs of the ant) and “horizontal” (the direction of the mouse's tail). These types of early experiences with spatial thinking prepare children for more advanced studies in geometry (NCTM, 2000).

Arts integration has been found to be a strong vehicle for academic learning (Burnaford, 2007; Goff & Ludwig, 2013; Klayman, 2006). Wolf Trap Institute for Early Learning Through the Arts develops and tests the use of performing arts at the prekindergarten and kindergarten levels to teach literacy, mathematics, and other subjects and to address children’s social-emotional development.

In the broadest terms, the Wolf Trap approach reflects positively on the value of arts integration to educators, arts educators, and researchers who study the role of arts in the academic environment. Wolf Trap’s commitment to Head Start and early childhood education is both part of its mission and tradition. The findings from the AEMDD study reinforce the importance of starting early, especially with children who have little or no exposure to the school setting.

Also note that Wolf Trap programs reflect a philosophy of continuous improvement. Teacher feedback from the AEMDD study suggests that the most valuable experiences occurred during visits by the teaching artist to schools and classrooms during the school year. In response, Wolf Trap streamlined its summer meetings between teachers and artists and created more planning opportunities during classroom consultations that teaching artists provided to teachers.

As part of the grant’s dissemination requirement, Wolf Trap has created an [online community of practice](#) so that teachers, artists, teaching artists, and policy makers can learn more about its arts-integrated approach and access resources, lesson plans, and instructional videos.¹ Wolf Trap also supports dissemination of its PD model by (1) holding training events for all of its 17 affiliates, a network of partner organizations around the country that use Wolf Trap’s arts-integration approach to early childhood education in their communities; (2) extending technical assistance on its mathematics PD residencies through affiliate visits; and (3) training teaching artists. Each affiliate implements the practices learned and materials obtained through the Wolf Trap training according to its setting, schools served, and financial supports.

The AEMDD evaluation also raises unanswered questions for the field and for researchers. For example, more research is needed to identify the methods and measures of arts integration and to explicate how teaching artists first understand the link between arts and other academic subjects and then use that knowledge to change teacher practices. Documentation by artists may be an important resource for this examination, as would be the validation of a rubric, such as the one designed for the AEMDD study to measure the practice of arts integration in the classroom (Ludwig & Goff, 2013). This evaluation also indicates a need to study how best to measure students’ arts learning during arts integration and what differences in implementation within and across schools and districts mean for the dissemination of Early STEM/Arts. Similar recommendations for needed research, focusing on social-emotional development, were highlighted in a recent literature review by the National Endowment for the Arts (Menzer, 2015).

In keeping with its focus on STEM subjects, Wolf Trap has begun developing and implementing classroom residencies for instructing young children in science and engineering. Although new science standards are of great interest to educators, such standards are not fully implemented in all school districts. Wolf Trap provides support for early childhood teachers by preparing them to use performing arts strategies in their science activities, perhaps giving some teachers a head start toward ensuring students will engage in and enjoy science early on.

¹ Visit the online community of practice website at education.wolftrap.org/.

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