After-School Math PLUS
Final Evaluation Report

AED
Center for School
and Community Services

After-School Math PLUS (ASM+)

Final Evaluation Report

By the

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I. INTRODUCTION AND SUMMARY OF PROJECT

In 2004, the National Science Foundation awarded the Educational Equity Center at the Academy for Educational Development (EEC/AED) a three-year grant to develop After-school Math PLUS (ASM+), a program designed to help students find the math in everyday experiences and create awareness about the importance of math skills for future career options.

ASM+ was developed in collaboration with the New York Hall of Science (NYHS) and the St. Louis Science Center (SLSC), with participation and support from afterschool centers in their communities. The Louisville Science Center (LSC) in partnership with the Lincoln Foundation Whitney M. Young Scholars Program was added as a third site in the 2005-06 school year. Activities were intended to help strengthen afterschool programs by complementing—not duplicating—classroom math experiences with experiences appropriate for the informal learning environment. The goal was to create a standards-based national model and materials for afterschool programs and museum partnerships.

ASM+ activities are age-appropriate and standards based, and are designed around four thematic units that are engaging to young people and compatible to afterschool settings: jumping rope, music, art, and the built environment. (See Appendix 1 for more information on each theme.) An emphasis on career connections and role models and connections to literacy are integrated into the activities. The activities, which were developed by math experts, are delivered by afterschool group leaders and young adult museum staff[1] to provide afterschool students and their families with rich and stimulating opportunities for informal math learning.

Afterschool programs that specifically address mathematics have been shown to be effective in improving students' attitudes about and understanding of the subject, as well as improving math outcomes. ASM+ incorporates the best practices of these programs while adding its own innovative elements: collaborations between science museums and local afterschool centers; utilization of young adult museum staff as role models and mentors; student-created math exhibits displayed in community-based public spaces; the integration of equity, literacy and career connections; ideas for including students with disabilities; and practical strategies for family involvement.

This report summarizes findings from the Academy for Educational Development's (AED's) evaluation of After-school Math PLUS (ASM+.) The evaluation was conducted by AED's Center for School and Community Services, with expertise in research and evaluation. The report is organized into five sections. Section one describes the goals and intent of the project. In section two, implementation of the project in year one, the pilot year, and year two is described. Section three summarizes the evaluation methods and data collection. In section four, findings from year-two evaluation activities are reported (year-one findings were reported in an earlier report). The last section, section five, summarizes key findings from the evaluation and questions for consideration in the planning and implementation of the replication ASM+.

[1] The young adult museum staff are known as explainers in New York, as teen staff in St. Louis and a VolunTeens in Louisville. The explainer staff in New York consisted of college-age students while in St. Louis and Louisville the teen staff consisted of high school students as young as 14 years old.

II. PROJECT IMPLEMENTATION

ASM+ was implemented in two pilot sites in 2004-05 (New York City and St. Louis) and in three sites in 2005-06 (New York City, St. Louis and Louisville). In New York, the New York Hall of Science partnered with the afterschool program at the Chinese American Planning Council (CPC). In St. Louis, the St. Louis Science Museum worked with the Adams Park Community Center in fall 2004 and thereafter with the afterschool program at Adams Elementary School. As noted earlier, the Louisville Science Center (LSC) partnered with the Lincoln Foundation Whitney M. Young Scholars Program.

A total of four themes were developed and implemented in the sites: Jump Rope, Built Environment ArtMath and MusicMath. Jump Rope and Built Environments were piloted in the first year and ArtMath and MusicMath were piloted in the second year. EEC staff provided technical assistance to all three sites throughout project implementation through regular site visits, phone calls and email.

Each site used a slightly different model to implement ASM+. In New York, activities were implemented in five sessions lasting approximately two hours at the afterschool program and five two-hour sessions at the museum. The activities were facilitated by the afterschool staff when sessions were held at the afterschool and by museum staff when they were held at the museum. Each theme culminated in a family day at the museum where families of students were invited to an exhibition and celebration of students' projects (e.g. in Built Environment students displayed and presented architectural charrettes). In St. Louis, all sessions were held at the afterschool center and facilitated by museum adult and teen staff. The site did not hold sessions at the St. Louis Science Center. In Louisville, all sessions were held at the Louisville Science Center and facilitated by the center staff and volunteer teens as well as teachers from the Whitney Scholars Program.

Students attending ASM+ in NYC were selected by the afterschool center director while in St. Louis they were self selected. In Louisville, participating students were part of the Whitney M. Young Scholars Program at the Lincoln Foundation. ASM+ was designed to serve a consistent group of students participating in all sessions for each theme. All of the students served by ASM+ were eligible for free or reduced-price lunch. The NYC site served predominately Asian-American students while the St. Louis and Louisville sites served predominately African-American students.

EEC conducted training with afterschool group leaders, museum staff and explainers for each theme. The day-long training for each theme included information on the skills and content knowledge covered by the theme, recommended strategies and approaches to implementing each activity, and equity and career awareness building.

The following two tables summarize key characteristics of each site involved in the first and second years of implementation of ASM+ including partners, dates implemented, number of staff and volunteers trained by EEC, number of student participants, and the length of time of the ASM+ sessions.

Table 1: Year 1 ASM+ implementation by site and theme (2004-2005)

	NEW YORK		ST. LOUIS	
	Jump Rope	**Built Environment**	**Jump Rope**	**Built Environment**
Afterschool Partner	Chinese-American Planning Council	Chinese-American Planning Council	Adams Park Community Center	Adams Park Elementary School
Museum Partner	NY Hall of Science	NY Hall of Science	St. Louis Science Center	St. Louis Science Center
Date Implemented	Fall 2004	Spring 2005	Fall 2004	Spring 2005
# of Staff trained	5 group leaders 5 museum explainers 1 adult museum staff	4 group leaders 5 museum explainers 1 adult museum staff	3 teen museum staff[2] 2 adult museum staff	8 teen staff 2 adult museum staff
# of students	23 students [4-5th graders]	24 students [4-5th graders]	8 students [6-8th graders]	10 students [4th graders]
# of hours of Afterschool Sessions Held	10 hours	18 hours	13 hours	4 hours
# of hours of museum sessions Held	10 hours	10 hours	Museum staff went to the community center and afterschool to conduct the activities in full.	

[2] 65 teen staff were trained in the Jump Rope theme and three of those helped implement the activities. SLSC trained all 65 teen staff before asking for volunteers to work on the ASM+ project. Ten adult museum staff were also trained; two implemented it.

Table 2: Year 2 ASM+ Implementation by site and theme (2005-2006)

	NEW YORK			ST. LOUIS		LOUISVILLE			
	ArtMath	**MusicMath**	**ArtMath-*Summer Session***	**ArtMath**	**MusicMath**	**Jump Rope**	**Built Environment**	**ArtMath**	**Music**
Afterschool Partner	Chinese-American Planning Council	Chinese-American Planning Council	Chinese-American Planning Council	Adams Park Elementary School	Adams Park Elementary School	Lincoln Foundation	Lincoln Foundation	Lincoln Foundation	Lincoln Foundation
Museum Partner	NY Hall of Science	NY Hall of Science	No museum partner-	St. Louis Science Center	St. Louis Science Center	Louisville Science Center	Louisville Science Center	Louisville Science Center	Louisville Science Center
Date Implemented	Fall 2005	Spring 2006	Summer 2006	Fall 2005	Spring 2006	Fall 2005	Fall 2005	Spring 2006	Spring 2006
# of Staff trained	5 teen staff 3 adult staff	4 teen staff 3 adult staff	Same staff from the Fall	3 teen staff[3] 2 adult staff	3 teen staff[4] 2 adult staff	5 teen staff 7 adult staff	Same as jump rope	3 teen staff 3 adult staff	2 teen staff 3 adult staff
# of students	23 students [3-4 graders]	21 students [3-4 graders]	18 students [5th graders]	50 students [3rd-5th graders]	25 students [3-5th graders]	41 [7th graders]	44 [8th graders]	41 [8th graders]	38 [7th graders]
# of hours of Afterschool Sessions Held	10 hours	18 hours	18 hours	13 hours	4 hours	All sessions were held at the Louisville Science Center.			
# of hours of museum sessions Held	7 hours	10 hours	1 session held at the Museum of Modern Art	Museum staff went to the afterschool to conduct the activities in full.		12 hours	13.5 hours	6.5 hours	6 hours

[3] As indicated in Table 1, the St. Louis site trained 36 teen staff during the ArtMath Professional development. Out of the 36 that were trained, 3 teens actually implemented the activities.

[4] 26 teens were trained but 3 implemented the MusicMath activities.

III. EVALUATION

AED's Center for School and Community Services conducted a formative and summative evaluation of ASM+ using a mixed method design. The evaluation addressed the following five areas: 1) nature and effectiveness of the partnerships between the museums and afterschool programs; 2) effectiveness of professional development on staff capacity to implement ASM+; 3) the impact of the curriculum and museum experiences on the students, young adult museum staff and group leaders; 4) the impact of the program on families' involvement in their children's math education; and 5) the quality of the materials and the impact of the dissemination strategies.

The evaluation methods used to address these areas included interviews with key partners (museum and afterschool staff and EEC staff); parent questionnaires; pre/post surveys of group leaders and young adult museum staff; observations of selected planning meetings, museum and afterschool staff training sessions and student sessions; and pre/post student assessments and attitude surveys that were piloted in fall/spring 2005-06. The evaluation design and instruments were developed with feedback from EEC/AED staff to ensure they were addressing questions of interest, using appropriate methods given the population served and fulfilling EEC's need for formative feedback. Data collection, administration and analyses are described in more detail in the results section.

IV. EVALUATION FINDINGS

The following section summarizes findings from the second year of implementation. Year one implementation findings are reported in AED's 2005 report. AED compared findings from year one to year two in our analyses for this report and we report instances where differences were noteworthy. A summary analysis covering both years of data collection is presented in the final section of this report.

A. 2005-06 Pre/Post group leader-explainer surveys

Group leaders at the afterschool centers and the young adult museum staff completed surveys at the beginning and end of each theme. The following table summarizes the number of afterschool group leaders and young adult museum staff who completed a survey at each site.

Table 3

Site	**Pre Surveys**	**Post Surveys**
Chinese-American Planning Council Afterschool [CPC]	4-adult staff	5-adult staff
New York Hall of Science Museum [NYHS]	0- adult staff 10-teen staff	1-adult staff 10-teen staff
St. Louis Science Center [SLSC]	4-adult staff 4– teen staff	4-adult staff 4-teen staff
Louisville Science Center/Lincoln Foundation	13-adult staff 10-teen staff	10-adult staff 9 teen staff
Total All Sites	45	43
Total Matched Pre/post All Sites	**19**	

The survey included questions related to attitudes and beliefs about the importance of mathematical literacy and approaches to mathematical instructions, preparedness to implement ASM+ and the need for additional professional development. To look at the impact of ASM+ on young adult museum staff and group leaders, we conducted an analysis comparing responses from the pre survey to the post survey. A total of 19 young adult museum staff or group leaders took both the pre and post surveys. Results are reported for the 19 respondents who took both.

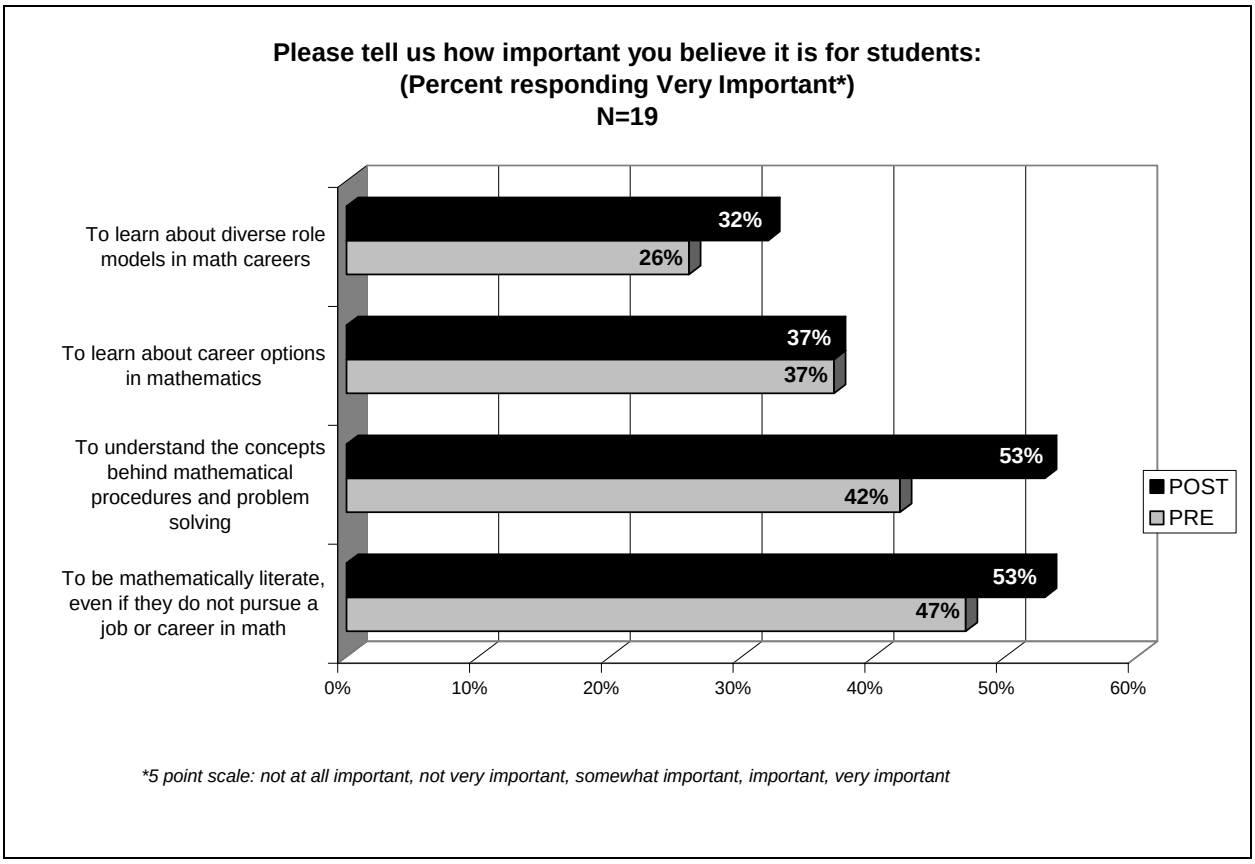
1. Beliefs about mathematics

Figure 1 shows the percentage of group leaders and young adult museum staff who reported that they believed it was very important for students to:

- Be mathematically literate, even if they do not pursue a job or career in math;
- To understand concepts behind mathematical procedures and problem solving;
- To learn about career options in mathematics; and
- To learn about diverse role models in math careers.

As shown in figure 1 below, there were small increases from the pre to post survey in the number of respondents that believed that it is very important for students to learn three out of the four categories. The greatest increase was in the belief that it is very important for student to understand the concepts behind mathematical procedures and problem solving (from 42% to 53%). The other two categories that reflect an increase were the importance of students to be mathematically literate even if they do not pursue a job or career in math (from 47% to 53%) and to learn about diverse role models in math careers (from 26%to 32%). There was no change in the percentage of respondents who reported believing it is important for students to learn about career options in math (37%) This may reflect the fact that sites reported not having enough time to implement the career and role models aspects of the curriculum. In response, EEC decided to revise the curriculum to integrate these two important aspects of the program across all activities, rather than as separate activities that are covered at the end of the themes.

Figure 1 Percentage of group leaders and young adult museum staff who responded "very important" to selected belief statements

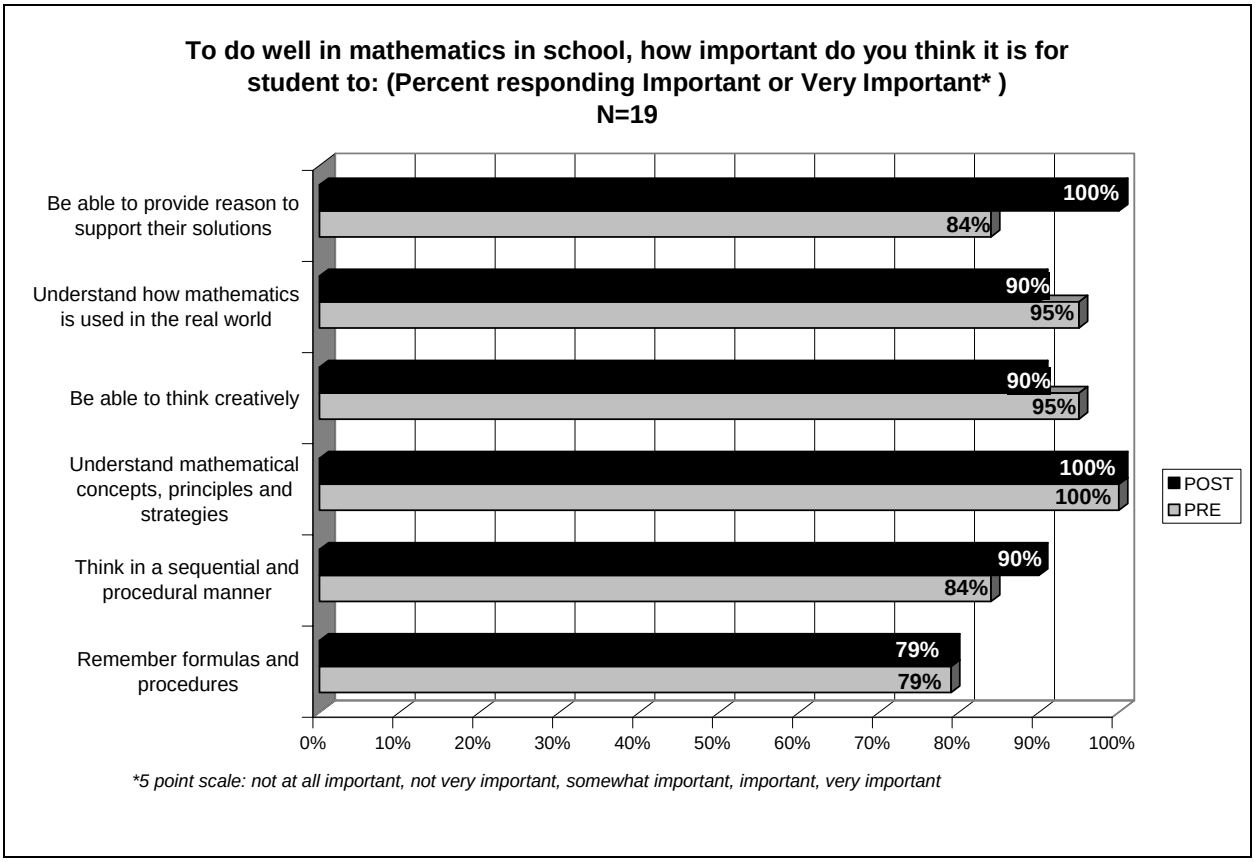


In figure 2, we show the percentage of group leaders and young adult museum staff who reported it was important or very important for students to know the following math concepts:

- Remember formulas and procedures;
- Think in a sequential and procedural manner;
- Understand mathematical concepts, principles and strategies;
- Be able to think creatively;
- Understand how mathematics is used in the real world; and
- Be able to provide reasons to support their solutions.

These skills represent core ideas about mathematical instruction that recent research shows are critical skills for students to develop especially those emphasizing instruction that fosters a deeper level of student understanding, creative approaches to problem solving, and the ability to communicate how they solved problems. Therefore, it is essential that group leaders and young adult museum staff understand and believe in the importance of each.

Figure 2 Percentage of group leaders and young adult museum staff who responded "important" or "very important" to selected belief statements



More than three-fourths of the respondents reported on the post survey that they believed each of the items was important or very important by the post survey. The biggest increase between pre and post survey responses was in the percentage who reported that in order to do well in mathematics; it is important or very important for students to be able to provide a reason to support their solutions. At the pre survey, 84 percent of respondents said they believed this was important or very important, increasing to 100 percent of respondents by the post survey. On two statements, there was a slight decrease between the pre and post survey. At the beginning of the activities, 95 percent of respondents reported that in order to do well in math, it is important for students to understand how mathematics is used in the real world and to be able to think creatively while at the end of the activities only 90 percent reported believing it was important or very important. Remembering formulas/procedures (79%) and understanding mathematical concepts, principles and strategies (100%) were rated very high in importance at the pre survey and saw no increase in the post survey. Given the small number of respondents (19) small fluctuations in either direction are not likely to be meaningful. Rather, overall findings indicate that even prior to implementing ASM+, group leader and museum staff beliefs were in line with the overarching philosophy promoted by the curriculum.

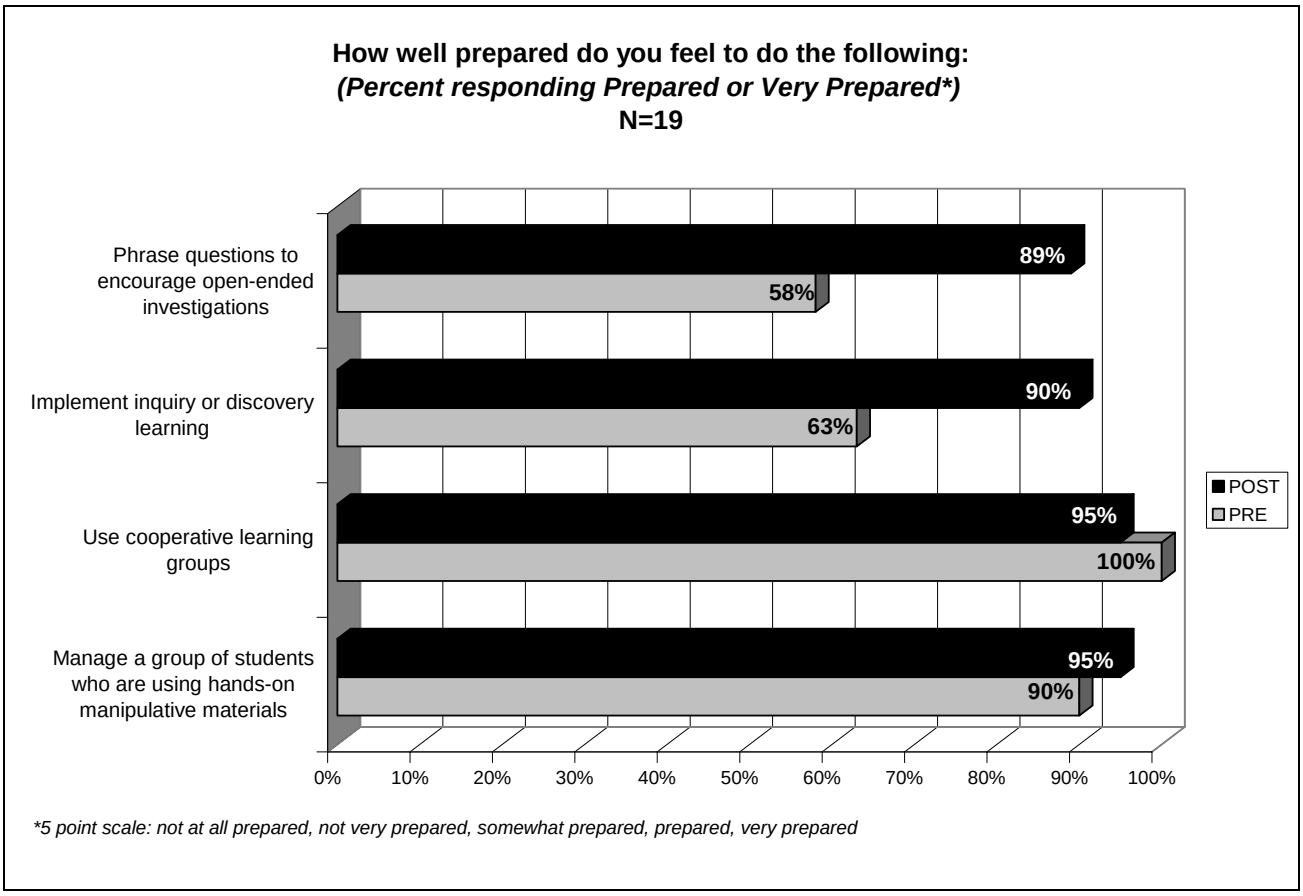
2. Preparing group leaders and young adult museum staff to implement ASM+

The pre/post survey asked group leaders and young adult museum staff how well prepared they were to implement certain teaching methods that were key characteristics of the ASM+ curriculum. Specifically, they were asked how well prepared they were to:

- Manage a group of students who are using hands-on manipulative materials;
- Use cooperative learning groups;
- Implement inquiry or discovery learning; and
- Phrase questions to encourage open-ended investigations.

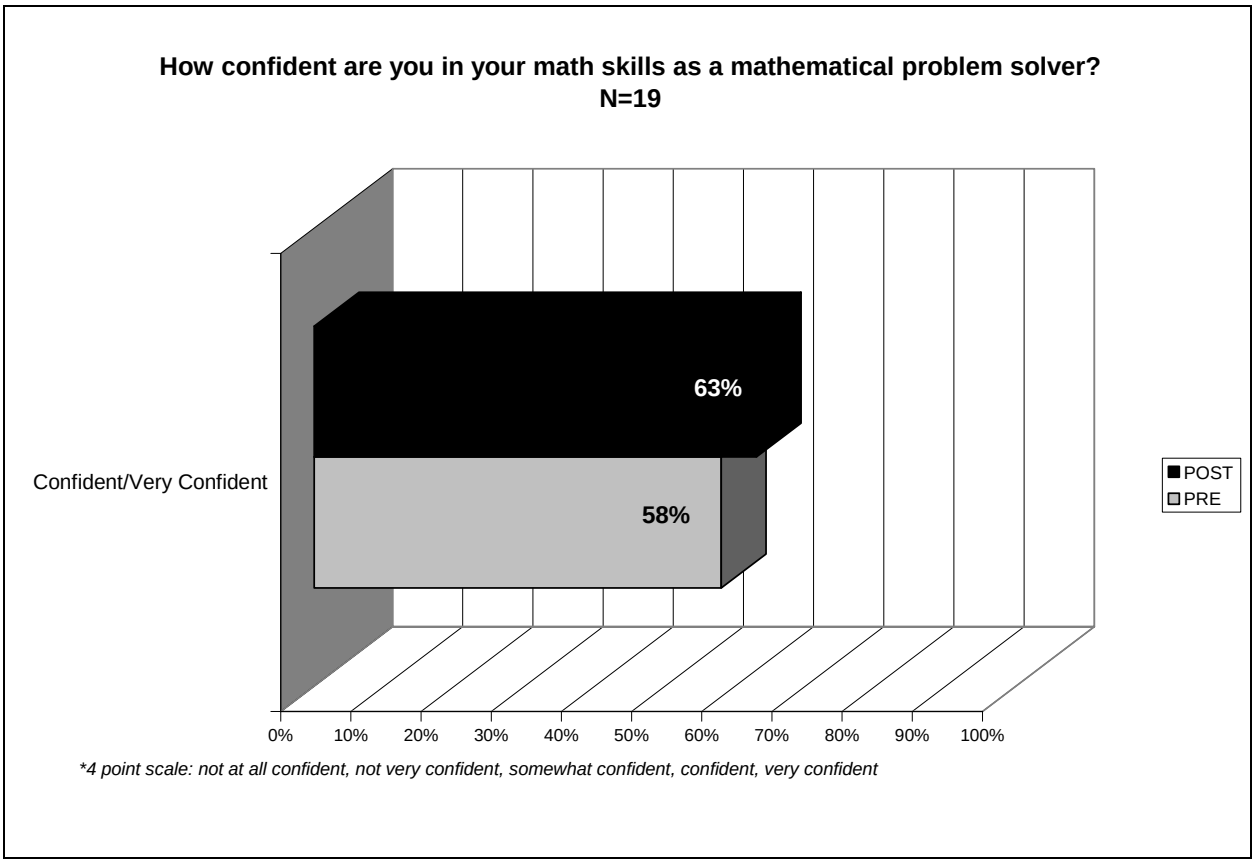
The results are presented in figure 3 below and show much growth in respondents' feelings of preparedness. Respondents reported an increase in three of the items asked about, with the biggest increases in feeling prepared to phrase questions to encourage open-ended investigations (from 58% to 89%) and implement inquiry or discovery learning (from 63% to 90%). The smallest increase was in managing a group of students who are using hands-on manipulative materials (from 95% to 100%), which is not surprising given that all but one respondent (95%) felt prepared to do so before implementing ASM+. Almost all of the respondents (95%) reported feeling prepared or very prepared to use cooperative learning groups before ASM+. This percentage decreased slightly at the post survey.

Figure 3 Percentage of group leaders and young adult museum staff reporting they were "prepared" or "very prepared" to implement selected aspects of ASM+.



In addition to feeling prepared to implement these teaching methods, nearly two-thirds of post survey respondents (63%) said they were confident or very confident in their skills as a mathematical problems solver, up slightly from 58 percent of respondents on the pre survey (see figure 4).

Figure 4 Percentage of group leaders and young adult museum staff who reported they were "confident" or "very confident" in their skills as a mathematical problem solver.

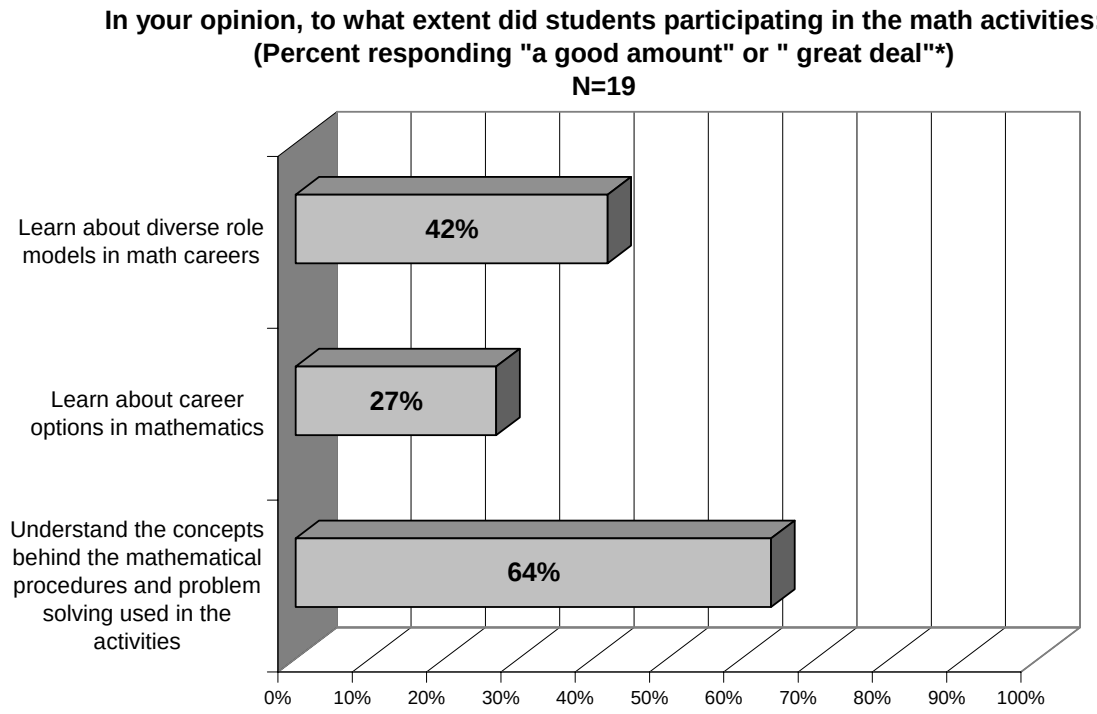


Nonetheless, 32 percent reported feeling somewhat confident and 5 percent reported feeling not very confident at the post survey, indicating that group leaders and young museum staff would benefit from additional professional development. This was confirmed through survey items in which respondents were asked the extent to which they needed additional professional development to effectively implement ASM+. At the post survey, two-fifths (42%) reported a moderate need and 5 percent reported a substantial need for professional development in learning how to use inquiry/investigation-oriented teaching strategies. Participants also indicated a need for professional development that deepened their own mathematical content knowledge (36% reported a moderate need in this area, 11% reported a substantial need).

3. Impact of ASM+ on students

A majority of respondents agreed that students participating in the ASM+ came to understand the concepts behind the mathematical procedures and problem solving used in the activities (53% a good amount and 1% a great deal) (see figure 5). Fewer agreed that students learned a fair amount or great deal about career options in mathematics (27%) or about diverse role models in math careers (42%). These findings indicate that the ASM+ activities did have a positive impact on students understanding of math, with less of a focus on learning about career options and diverse role models.

Figure 5 Percentage of group leaders and young adult museum staff who reported that students learned a "fair amount" or "a great deal" on selected items.



In open-ended questions, group leaders and museum staff were asked what they liked best and least about the activities and if they had recommendations for the program. Responses indicated that group leaders and young adult museum staff saw the value in combining mathematical concepts in everyday activities.

> *The best part of the MusicMath activities was combining activities with math that includes music and including use of fractions connected with the beat.*

> *The children had the opportunity to be creative and manipulate materials while learning interesting math concepts.*

In responding to what they liked best, three respondents said:

> *Art and music—kids got to be creative and active.* [Not emphasizing] *reading or writing appeals to different types of learners.*
>
> *I really enjoyed seeing the kids discover mathematical terms in art such as symmetry and tessellations.*
>
> *I liked the fact that the children got the concept of what was being done and that they enjoyed every bit of it from my viewpoint.*

Two respondents had suggestions for the program:

> *The reinforcement of basic skills such as measuring is vital for this project. Reduce assumptions that may increase the length of time for the completion of the project. Constant review is important.*
>
> *There should be more collaboration between the museum and the afterschool site when doing activities 4 and 5 of the MusicMath curriculum.*

B. Pre/Post student surveys

AED piloted several instruments to assess the impact of ASM+ on students' attitudes, skills and knowledge. One instrument was a pre/post survey with items related to students' experience in the program and attitudes about math. Table 4 shows the number of respondents to each survey, by site and theme. Some students participated in more than one theme. The first survey they took was considered a pre survey and the last was treated as the post.

Table 4 Summary of Student Attitude Surveys Administered at Each Site in Year 2

Site	Theme	Pre	Post	Matched Pre-Post
NY	Art	--	21	**13**
	Music	22	26	
St. Louis	Art	--	12	**0**
	Music	14	13	
Louisville (Cohort 1)	Jump Rope	36	37	**33**
	Music	--	33	
Louisville (Cohort 2)	Built Environment	35	34	**31**
	Art	--	32	
Total		**107**	**208**	**77**

The survey included 11 mathematics attitude items from a survey developed by TERC, an education research and development organization. TERC based the survey on Elizabeth

Fennema's mathematics attitude survey for high school students. The survey items asked students if they agreed, disagreed or were not sure about statements like: "boys are no better at math than girls. As shown in table 5 below, students who participated in ASM+ programs showed an overall small increase in positive attitudes between the pre and post measure. The changes were not statistically significant.

Table 5 Students' average pre and post math attitudes assessment scores (N=77)

Average Pre Score	Average Post Score
16.90	**17.04**

In addition to the questions on mathematics attitudes, the survey included items asking students how much they liked the program. Table 6 shows that 40 percent or more of students reported liking the activities from the Built Environment, Art and Music themes "a lot." Fewer students (22%) reported liking activities from the Jump Rope theme "a lot". Very few students reported not liking activities from any of the themes.

Table 6 Students' ratings of each theme

How much did you like the following activities?	Not at all	A little	A lot
Jump Rope (N=37)	8%	70%	22%
Built Environment (N=33)	3%	55%	42%
Art (N=80)	13%	46%	41%
Music (N=45)	4%	56%	40%

Further, as shown in table 7, most students agreed that the program was fun, interesting and that they learned a lot at the program, regardless of theme.

Table 7 Percentage of students who "agree" with statements about the program, by theme.

HOW MUCH DO YOU AGREE OR DISAGREE WITH THE FOLLOWING STATEMENTS?					
	Jump Rope (N=38)	**Built Environment** (N=33)	**Art** (N=80-81)	**Music** (N=64**)**	**ALL THEMES** (N=215-216)
14. The program has been fun	58%	67%	67%	66%	65%
15. This program was interesting	74%	70%	73%	73%	73%
16. I have learned a lot at this program	76%	64%	65%	69%	68%

Six items on the post survey asked students to compare their attitudes and skills in math before and after attending the program (see table 8). The responses were generally favorable. Specifically, 44 percent of students said they were better at math, 32 percent said they liked math more and over half (54%) said they were more sure about being able to do math than they were before coming to ASM+. Nearly two-fifths were more interested in math after coming to the

program. Only 18 percent said they were afraid of math before coming to the program, and of those students, half said they were less afraid of math now than they were before coming to ASM+.

Table 8 Percentage of students who responded to the following statements.

POST Surveys N=129-131	Yes	No	Not Sure
17. Are you better at math than you were before coming to this program?	44%	28%	28%
18. Do you like math more than you did before coming to this program?	32%	45%	23%
19. Are you more sure about being able to do math than you were before coming to this program?	54%	21%	26%
20. Do you find math more interesting now than you did before coming to this program?	38%	38%	24%
21. Were you afraid of math before coming to this program?	18%	71%	11%
22. Are you less afraid of math than you were before coming to this program? (reported only for those who said they were afraid of math in Q. 21, n=24)	50%	46%	4%

In open-ended questions, students were asked about their favorite part of the program. Selected responses included:

I liked everything about it. It was fun, challenging and hard work so I liked it.

To learn how you read music notes and comparing it to math, makes it easier.

When asked about suggestions on how to improve the program, two students said:

I would like to have activities that relate to music nowadays.

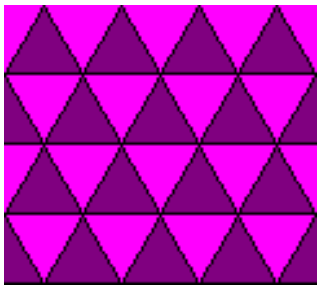
I would like to learn more about patterns and tessellations.

C. Student performance assessments

EEC created and piloted performance assessments to measure the impact of the program on the mathematical skills and knowledge addressed in each theme. (See Appendix 2 for copies of the assessment tools.) The assessments were administered individually to students at the beginning of the cycle and again at the end for three themes: ArtMath, MusicMath and Jump Rope. Results are presented below.

1. ArtMath

For the ArtMath assessment, students were shown at the beginning and end of the theme the geometric pattern below and asked to describe what they see and to describe any math they see in the picture. They were also asked if they see symmetry in the picture. Nearly all students (14 out of 15) were able to recognize and identify more mathematical concepts at the end of the theme than at the beginning of the theme. Students were able to identify and define concepts such as symmetry, asymmetry, reflection, and tessellations.



Some of students' comments about the pattern showed a deeper understanding of the concepts taught through the theme. For example, one student immediately recognized the pattern in the post assessment as a tessellation and when asked if he saw symmetry he replied, "Tessellations ***are*** symmetry." One student responded to the post assessment by going beyond identifying concepts to demonstrating them by manipulating the patterned paper to show reflection, translation, and glide rotation. This student took the position of "teacher" to slowly and carefully demonstrate the various symmetries displayed in the pattern, showing confidence in his understanding of these concepts. When asked if he could show symmetry a different way he tore pieces of paper into triangles and continued to instruct. Some students made a direct connection between the pattern shown in the assessment and the art explored through the theme. For example, when asked to describe any math that he saw in the picture, one student replied, "It's like Escher's math."

2. MusicMath

Students were shown an 8 x 8 piece of paper in whole and another 8 x 8 piece cut into the following sizes: 1/16, 1/8, 1/4, 1/2 of the whole (see figure below).

<table>
<tr><td rowspan="3">1/2</td><td>1/16</td><td>1/16</td></tr>
<tr><td colspan="2">1/8</td></tr>
<tr><td colspan="2">1/4</td></tr>
</table>

With the pre-cut pieces of paper placed on top of the whole piece (the pieces were not labeled with the fraction), students were asked to use the pre-cut pieces to show, one at a time, what 1/2 of the whole is, what 1/4th of the whole is, what 3/8ths of the whole is, and what 5/16 of the whole is. At the pre assessment, only 4 out of 51 students (8%) correctly represented all four fractions. By the post assessment, 20 students (39%) correctly represented all four fractions. A comparison of students' pre and post assessment responses showed that at the post assessment students:

- demonstrated increased understanding of fraction values;
- increased facility and speed in adding and subtracting fractions;
- recognized incorrect answers more frequently;
- used strategies for correction that were a part of the curriculum;
- demonstrated increased confidence while answering the math assessment questions; and
- used the assessment pieces as math manipulatives to find the correct answers.

Further, students who consistently used strategies from the theme performed better on the post assessment. The following descriptions give examples of these changes.

In the pre assessment, one student struggled with the 3/8^{ths} and 5/16^{ths} questions and took the longest of any child to complete the assessment. He tried to combine pieces of paper in various ways without success even after several tries. In the post assessment, he didn't hesitate and completed the assessment in a very short time.

In the pre assessment, one student was only able to answer the first two questions. In the post, he was able to answer every question without hesitation and he was able to show each answer several ways (for example, 5/16th was ¼ plus 1/16th or using the background card obscuring 9/16th and showing the 5/16^{ths} as empty space). At the end of the assessment he even replaced all of the fraction pieces on the background card and added the values out loud as he did it.

One student was able to answer the first two questions of the pre assessment but struggled with the rest. In the post, he answered the first three without hesitation. On the fourth (5/16ths) his initial answer was wrong and he immediately recognized it. He proceeded to subtract fractions until he had the correct answer. (This is exactly the process used in checking the MusicMath measures.)

3. Jump Rope

To assess students' understanding of the term 'data' and knowledge about different ways to represent data, students were asked: What do you think of when you hear the word data? What are some visual ways to show data? Give examples. All of the students (N=30) were able to respond to theses questions at the pre and post assessments. Students showed clear growth at the post measure. Specifically 43 percent of students were able to give a more detailed answer when responded to what they think about when they hear the word data. For example, one student wrote at the pre assessment: "I think of something you collect like information". At the post, he/she wrote: "I think of what you collect in an experiment to prove the experiment hypothesis wrong. You compare it and contrast it. You can put in graphs, charts, etc."

More than half the students (55%) were able to list more ways to represent data visually at the post measure. For example, one student wrote "Graphs; tables and plots" at the pre. At the post, they added "line graphs, pie charts, Venn diagrams, bar graphs, tables, scatter plots, stem & leaf plot". Sixty percent of students were also able to provide more examples of visual ways to show data at the post assessment. For example, one student at the pre drew only the shell of a table and in the post drew a line graph, bar graph and a pie chart.

D. Partner Interviews

Key partners from the New York City Site (the Chinese-American Planning Council and the New York Hall of Science) were interviewed at the end of year one. Evaluators also interviewed key partners from the Louisville site from the Whitney M. Young Scholars Program at the Lincoln Foundation and the Louisville Science Center at the end of year two. The partners were asked to provide feedback on the activities and professional development provided to group leaders and explainers as well as the challenges and facilitators to implementing the project.

Several key issues emerged from these interviews. First, joint planning with the museum and afterschool center was deemed by the partners as critical. Similarly, implementation required good communication between the museum and afterschool-center particularly around schedules and planned activities. For example, there was some confusion between the museum and afterschool center around how the activities would be implemented. One partner commented that the activities had been implemented differently that she had expected based on the professional development she received. More direct communication and joint planning by the museum and afterschool center would have addressed these differences in conceptions and allowed for better coordination of the activities at both sites.

One partner also argued for more collaboration between sites to implement the activities while another expressed the need to have adequate planning time between partners and a set schedule to meet with the student.

> *The one thing that would have facilitated the partnership during the Built Environment theme was to have the NYHS staff present at the CPC afterschool during the five activities that were done by the students so that the concept of scaling could have been stressed a little more. The NYHS staff could have helped in explaining scaling in such a way that it could be understood before they were to go to the NYHS for the building of their community.*

> *Not having planning time before the activities were implemented. We had the students every other Saturday starting at 8:30am and didn't have to time to prepare the Whitney Scholars' teachers on what was to be done that day. We have suggested that if we are to continue working with the Lincoln Foundation we would stay later on Saturdays to meet and plan for the next activity. Another challenge is that the students only come together 2 Saturdays a month which limited what we could do and the time it took us to do it.*

Another theme from the interviews was the importance of consistent participation by students. For the first theme, Jump Rope, students came to the museum once a week over a period of several weeks. To keep attendance at a constant level, substitute students were sent to the museum to fill in for any absentees each week. Since the activities were designed to build on one another, students who did not come consistently were not able to understand all of the activities. For the second theme, the Built Environment, students came to the museum every day for a week. Partners agreed this was a much better way to implement the project in that it fostered more consistent attendance and avoided large periods of time between activities at the museum.

One partner noted that students needed additional skill building to participate in the activities. She suggested spending more time building up these skills.

> *While doing the built environment theme, it was discovered that the students didn't have experience with the scaling concepts so it was hard to do all the activities and have them ready to build their community at the museum. In the future, the activities should build up these skills.*

In terms of professional development one site expressed the importance of having access to an EEC staff person for technical assistance. All partners felt that the PD sessions went well. One partner felt that at their site that the teen staff didn't have a real role in implementing the activities.

> *I'm a bit disappointed that it didn't go well for our teen staff. They didn't have much to do. I think there should be a part written into the curriculum that explains what the teens role is and how do they interact with students.*

E. Parent questionnaires

Parents of the students who participated in both the Art and Music themes in New York City were asked to complete parent questionnaires. The questionnaires were given to the parents shortly after the culminating events at the New York Hall of Science at the end of each theme. Students of most surveyed parents participated in both themes. There was no parent involvement in St. Louis so a questionnaire was not administered at the site. At the Louisville site parents were only involved in the first culminating event for the jump rope and built environment themes and were given the questionnaire at that time. The site did try to follow-up with parents to get them back but were unsuccessful in doing so.

As shown in the table below, most parents reported that they thought their child enjoyed the ASM+ activities and that they saw a change in their child's ability and interest in math since participating in ASM+. Parents were more positive after MusicMath than ArtMath, which is likely due to the fact that most children participated in both themes, art first and then music. Parents may have seen greater impact on their children after having participated in two themes, having had twice as much exposure to ASM+. The following table shows results from the parent questionnaire.

Table 9. Questionnaires given to parents at the New York site culminating event

PARENT QUESTIONNAIRE		
How much do you think your child enjoyed the activities?	**Art N=17**	**Music N=14**
A little/Not at all	12%	7%
Some	35%	7%
A good amount/A great deal	53%	86%
Have you seen a change in your child's ABILITY in math since participating in the activities?	**Art N=17**	**Music N=14**
YES	47%	79%
Have you seen a change in your child's INTEREST in math since participating in the activities?	**Art N=17**	**Music N=14**
YES	47%	86%
Do you think the changes are as a result of his/her participation in the afterschool math activities?	**Art N=14**	**Music N=14**
YES	86%	79%

Overall, these findings indicate that parents were very positive about the program. Parents' comments about the impact of ASM+ on their children include the following:

> [He] u*ses a ruler more accurately.* [He] *measures better.* [ArtMath]
>
> *She wants to do her homework by herself. She has more confidence*. [ArtMath]
>
> *It is small, but he seems to point out more shapes in ordinary things*. {ArtMath}
>
> *Her math skills have drastically improved.* [MusicMath}
>
> [My child] *liked the ArtMath activities.* [She is] *more willing to try to measure and draw on her own.* [ArtMath]

V. SUMMARY OF KEY FINDINGS

- Group leaders and explainers showed some positive shifts from the pre to post survey in their attitudes and beliefs about mathematics, particularly the belief that it is very important for students to understand the concepts behind mathematical procedures and problem solving.

- Most group leaders and explainers had positive beliefs about approaches to teaching mathematics at the pre survey indicating that, even prior to implementing ASM+, their beliefs were in line with the overarching philosophy promoted by the curriculum. For example, nearly all respondents reported it was important or very important for students to understand how math is used in the real world and to be able to think creatively.

- With the professional development and support provided by the project, group leaders and explainers felt adequately prepared to implement ASM+.

- A noteworthy proportion of group leaders and explainers still felt that they had a moderate or substantial need for professional development in inquiry-oriented teaching strategies and in deepening their own math knowledge. A few were not confident in their problem solving skills. These findings indicate that although group leaders/explainers felt prepared to implement ASM+, they would benefit from additional professional development.

- According to group leaders and explainers, ASM+ activities had a positive impact on students' understanding of math and provided diverse role models. They saw less of an impact on students' understanding of career options.

- Students who participated in ASM+ programs showed an overall small increase in positive attitudes about mathematics between the pre and post measure. The changes were not statistically significant.

- Students responded favorably to all of the themes, with most reporting they liked the activities, that the program had been fun and interesting, and that they learned a lot at the program. Students also reported a positive impact on their skills, confidence and interest in math.

- Students showed a small but not statistically significant increase in positive attitudes about mathematics.

- Pre/post performance assessments of students' knowledge and skills showed that many students did experience positive gains including increased understanding of mathematical concepts such as symmetry and tessellations, facility with fractions and knowledge of visual displays of data.

- Parents were very positive about the program. Most believed their child enjoyed the activities and that their child's participation played some role in improving their child's ability in math. In addition, most surveyed parents agreed that participation in ASM+ increased their child's interest in math.

- Joint planning with the museum and afterschool center was critical. Implementation required good communication between the museum and afterschool center particularly around schedules and planned activities.

- Students may needed additional skill building to participate in some of the activities.

- Year two evaluation results were consistent with findings from year one.

Appendix 1: After-School Math PLUS Summary of Themes

Jump Rope Math

The five activities in this theme center on jump ropes—familiar objects we all have used on the playground, at the gym, or for serious athletic training—as vehicles for collecting, representing, and interpreting data. As they work on the activities, students create bar graphs, line graphs and Venn diagram; they conduct and analyze surveys; they measure various jump ropes in relation to their own heights using standard and non-standard measuring tools; and they count by multiples as they plot information on their graphs. By collecting and reflecting on data, students develop understanding and skills that are essential for informed decision-making. The following content standards are covered in this theme: data analysis and probability; number and operations, problem solving, communication; representation.

After completing the series of Jump Rope activities, students work on exhibits at the partnering museum. Museum "explainers" facilitate the design of student exhibits based on the questions that arose during the theme, and the investigations they planned and carried out at the center. Their exhibits are shared with family and friends at a culminating event.

Built Environment

In this series of five activities, students explore the immediate environment within and outside their center, looking at windows, doors, buildings, streets, and fences with a mathematical eye. Students make their own meter sticks and construct a tool out of rope to measure, collect data, convert it to scale on graph paper, and draw representational maps using scale and symbols. Students use what they have learned about scale, measurement, and their immediate built environment to create a blueprint for an "ideal" community. The following content standards are covered in this theme: data analysis and probability; measurement; algebra; geometry.

During their sessions at the museum, students use their blueprints as a guide for building a charrette—a scale model representing their ideal community which will be shared with family and friends at a culminating event.

ArtMath

In the five ArtMath activities, students explore the myriad ways in which art and math interconnect. They create kaleidoscopes and look at M.C. Esher's art to understand tessellations—a concept that is found in both math and art. They experience the role of scale, geometry, tessellation, symmetry, measurement-all essential math skills and concepts. They learn about Poet Mondrian's art that uses geometry and asymmetry. The following content standards are covered in this theme: geometry; algebra; problem solving; communication; connections.

During their sessions at the museum, students create an art exhibit that demonstrates math concepts from the theme (e.g., tessellations, symmetry, asymmetry). The artwork is displayed for family and friends at a culminating event.

MusicMath

In the five MusicMath activities, students explore the many ways that music and math are connected. They begin to by listening and moving to music and constructing simple four-count rhythm patterns. They then extend the patterns to create new arrangements and, eventually, a musical composition. The following content standards are covered in this theme: algebra; problem solving; communications; representation; connections.

During their sessions at the museum, students make their own instruments so they can perform their composition in front of family and friends at the culminating event.

All four themes also include activities and connections that emphasize equity; inclusion; cultural links; career and role models.

Appendix 2: After-School Math PLUS Student Assessments Activities

ArtMath Student Assessment

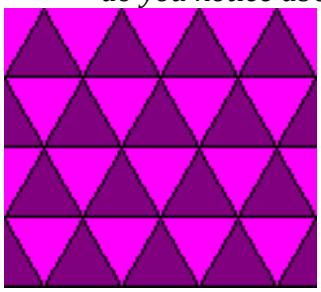
After-School Math PLUS

STUDENT ASSESSMENT INTERVIEW
ART THEME

INTERVIEWEE: **Date**:
AGE:

Introduction: We're asking several students to look at a picture and tell us some things about it. There are no right or wrong answers. We just want to hear what you think about the piece.

1. Here is a picture. Please describe what you see in this picture. *(Try not to probe- unless student doesn't say anything. Then probe very openly- e.g. what jumps out at you? What do you notice about this piece?*



2. Please describe any math you see in this picture.

3. Do you see any symmetry in this picture?

MusicMath Student Assessment

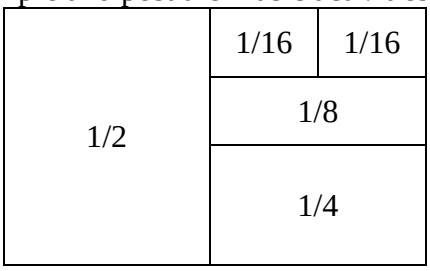
After-School Math PLUS

STUDENT ASSESSMENT INTERVIEW
MUSIC THEME

INTERVIEWEE: **Date**:
AGE:

Pre Instructions on Set-up:

Make sure before each student arrives to be interviewed to set up the 8x8 size paper with the pre-cut pieces of paper all on top as to cover the whole surface area (see below, do not label each piece with the fraction). The cut-up pieces of paper will be in the following sizes: 1/16, 1/8, 1/4, 1/2 of the whole. The purpose of this activity is to see what the students know about fractions pre and post the music activities that will be implemented at your site.



With each student, show them the piece of paper with the other pre-cut pieces on top. Explain to them that this represents a whole. Then take off all the pre-cut pieces and put them to the side. Ask them the following questions and notate what they say and do for each.

Using the pre-cut pieces can you show me what…

1/2 of the whole is?

1/4 of the whole is?

3/8 of the whole is?

5/16 of the whole is?

Jump Rope Student Assessment

Name:_____ Date: _____

After-School Math PLUS: Jump Rope Assessment

What do you think of when you hear the word “data?”

What are some visual ways to show data?

Give examples

The Academy for Educational Development (AED) is an independent, nonprofit organization committed to addressing human development needs in the United States and throughout the world. As one of the world's foremost human and social development organizations, AED works in five major program areas: U.S. Education and Workforce Development; Global Learning; Global Health, Population and Nutrition; Leadership and Institutional Development; and Social Change. At the heart of all our programs is an emphasis on building skills and knowledge to improve people's lives.

The AED **Center for School and Community Services** is part of AED's U.S. Education and Workforce Development Group. The Center uses multidisciplinary approaches to address critical issues in education, health, and youth development. To achieve its goals, the center provides technical assistance to strengthen schools, school districts, and community-based organizations. It conducts evaluations of school and community programs while striving to provide the skills and impetus for practitioners to undertake ongoing assessment and improvement. The Center also manages large-scale initiatives to strengthen practitioner networks and accelerate systems change. Lastly, the Center uses the knowledge gained from its work to advocate for effective policies and practices and disseminate information through publications, presentations, and on the World Wide Web. In the past 27 years, the Center has undertaken over 125 evaluation, technical assistance, and dissemination projects in 90 cities and 40 states.

In 2005, the Educational Equity Center at AED (EEC) was formed. The Center is an outgrowth of Educational Equity Concepts, a national nonprofit organization with a 22-year history of addressing educational excellence for all children regardless of gender, race/ethnicity, disability, or level of family income. EEC's goal is to ensure that equity is a key focus within national reform efforts to ensure equality of opportunity on in schools and afterschool settings, starting in early childhood.

AED is headquartered in Washington, DC, and has offices in 167 countries and cities around the world and throughout the United States. The Center for School and Community Services is mainly located in AED's office in New York City, with some staff in the Washington, D.C. office and throughout the country. For more information about the Center's work, go to the Center's website at www.aed.org/scs or contact Patrick Montesano or Alexandra Weinbaum, co-directors, at 212-243-1110, or e-mail sweinbau@aed.org or pmontesa@aed.org.

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