

Public Audience Front-end Research:  
Boys & Girls Club



by  
**Garibay Group**

2008

**with the generous support of**



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## **Oregon Museum of Science**

Public Audience Front-end Research:

Boys & Girls Club

***Garibay Group***

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## Overview and Evaluation

OMSI is developing Access Algebra, a project designed to develop and test effective strategies for math learning in informal settings and to help train science museum interpretive staff to facilitate informal family math learning experiences. Garibay Group is working with OMSI on this project as the external evaluator. This report presents the results of the front-end evaluation relating to the public audience and exhibit component of the project.

### *Project Description*

The Access Algebra project will develop a 5,000 square foot interactive, traveling exhibit, targeted at 10 – 14 year olds and their families.

The exhibit focuses on creative problem solving using algebraic thinking, a process that involves looking for patterns and relationships among data, representing those relationships mathematically, and using those representations to describe, analyze and predict.

The thematic approach the OMSI team has identified is art and design which would engage visitors through activities based on specific art/design jobs and activities, such as music producer, fashion designer or even aeronautical engineer.

### *Evaluation*

The aim of front-end evaluation is to assist the project team in making informed decisions about the exhibit's development through audience research.

The evaluation conducted by Garibay Group explored the perspectives of youth in the target age range as well as their parents. In order to best leverage staff resources, Garibay Group conducted research with participants from the Boys and Girls Clubs in Portland while OMSI staff, conducted research with visitors at the Museum. This report discusses results of the study conducted by Garibay Group.

### **Front-End Focus**

Key topics identified by the OMSI team for exploration in this phase of evaluation included:

- Target audiences' conceptions of algebra.
- Perceived usefulness of math and algebra.
- What seems to characterize fun experiences with math for the target audience.
- Reactions to the proposed exhibit approach.

## Overview and Evaluation, cont'd

### *Methods*

The primary data collection method for this study was depth interviews. These semi-structured interviews allow researchers to focus on specific topics while still allowing exploration of unanticipated issues.

Youth from the Blazer Boys and Girls Club between the ages of 10 – 14 were interviewed in groups of two or three respondents, with interviews lasting approximately 50 minutes. (Two youth were interviewed individually when other scheduled participants did not show.) We interviewed a total of 27 youth.

Parents with children in the target range were also interviewed individually, with each interview lasting approximately 30 minutes. We interviewed a total of 11 parents.

Interviews incorporated projective techniques (e.g., a math activity) designed to elicit responses that might otherwise be difficult to obtain via conversation only and to gain an in-depth understanding about respondents' attitudes and perspectives (Catterall and Ibbotson, 2000).

pattern block activity to facilitate conversation about math-related topics and to begin to uncover the ways participants thought about and discussed math-specific ideas. Later in the interview, respondents were asked to react to photo collages of five different jobs in the art/design field. The collages were intended to illustrate the exhibit approach.

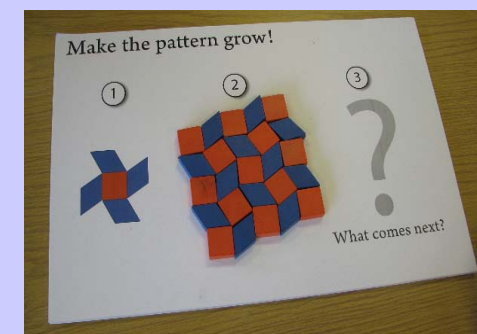
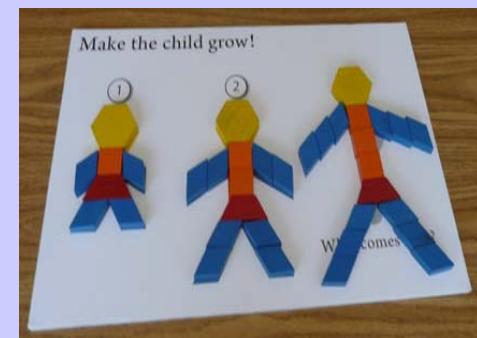
This study also included an online survey available to all five Portland-area Boys and Girls clubs. The goal of the survey was to obtain responses from the target audience on potential exhibit activities not covered in the interviews. In an attempt to obtain a larger response sample, the survey also included several questions included in the interview component.

### *Sampling*

This study used purposive sampling (Babbie, 1998) in selecting interview respondents. In purposive sampling respondents are selected based on criteria that best meet the specific goals of the project. Specifically, we strived for an even gender and age distribution of youth between 10 – 14 years of age.

### **Pattern Block Activity**

Participants were shown two steps out of a sequence of two different patterns and asked to build “what comes next?” with blocks. The photos below show one group’s completed version of the two challenges.



## Overview and Evaluation, cont'd

Parents selected for the study were parents of the youth being interviewed.

For surveys, all youth in the target age range from the five Portland Boys and Girls clubs were invited to participate and were given the opportunity to complete the survey during a one week period.

Interview data were collected during the week of April 28. Survey data were collected during the week of May 19, 2008.

### *Limitations*

As with any evaluation of this scope, there were limitations. During recruitment, staff had difficulty recruiting older youth both because of conflicts in their schedules and less willingness to participate in interviews. Therefore, this study included mostly youth at the younger end of the target age range. We noted the same trends in responses to the survey. Therefore, opportunities to explore the perspective of teenagers, who may have had more substantial exposure to algebra, were limited.

## Conceptions of Math and Algebra

### Overview

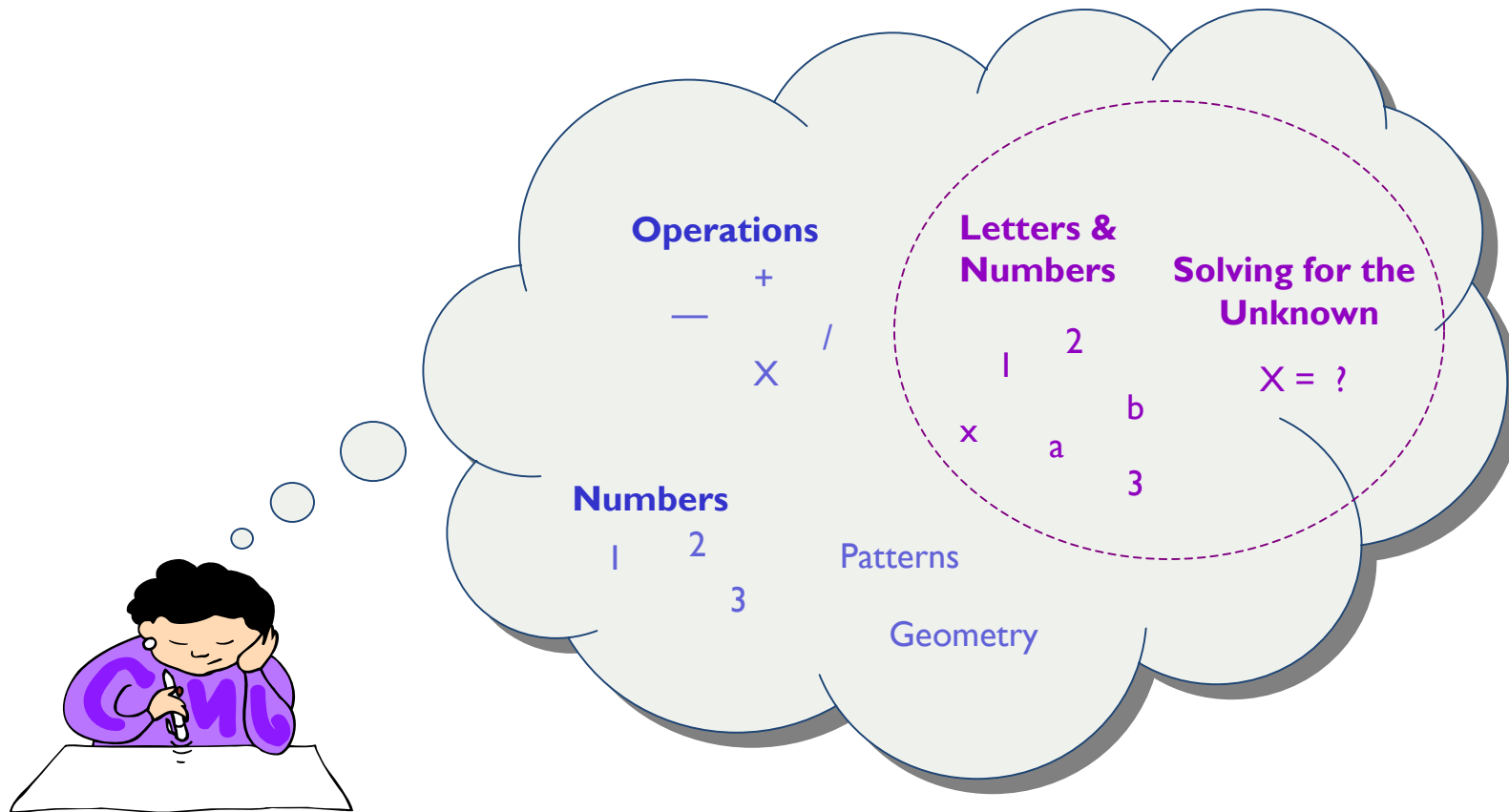
- Both children and adults most commonly associated math with numbers and operations (e.g., subtraction).
- Respondents had a range of exposure to and understanding of algebra, but most could only give a basic and a somewhat fuzzy description of it.
- Algebra was seen as a type of math. Younger children often associated it with letters and numbers. Older children and adults, typically described algebra as being about the process of solving for and unknown number.
- Respondents, regardless of age, did not see algebra in the more conceptual “algebraic thinking” ideas on which the development team hopes to focus.



Many respondents saw some math in the pattern block activity but few saw algebra in it.

## Common Conceptions of Math and Algebra

This graphic illustrates the ways respondents most commonly thought about math and algebra. Both children and adults associated math with numbers and operations (e.g., subtraction or multiplication) and saw algebra as a subset of general math. Younger children—who typically had little exposure to algebra—described it as a type of math that included numbers and letters. Older youth and adults described algebra as being about solving for the unknown and focused on the symbols and equations, but did not see algebra in terms of the more conceptual “algebraic thinking” ideas on which the exhibit focuses.





## Common Conceptions of Math and Algebra, cont'd.

### *Children's Conceptions of Algebra*

Given the broad target age range of 10 –14, child participants had a wide range of exposure to algebra and, consequently, their degree of understanding and interest in algebra also varied widely.

For younger respondents who had heard of algebra (e.g., seeing their older siblings doing algebra homework), but had not taken the subject in school, algebra was seen as a type of math that involved “letters and numbers,” although the relationship between the two was not clear to these respondents. Older children with more exposure to the subject described algebra as being about solving for the unknown number/letter.

Children generally did not talk about algebra in terms of more sophisticated concepts, such as patterns, prediction or generalization. In fact, they often had difficulty finding the words to articulate a clear description of algebra. As one child said,

*“I know it’s a form of math but I don’t know what else to say.”*

### *Adults' Conceptions*

Adults' conceptions of math and algebra generally were not significantly different than older children's. However, a few adults attempted slightly more sophisticated explanations. For example, some talked about algebra being about figuring out the “outcome” and as “problem solving.” Nonetheless, overall, adults' conceptions were similar to those of older youth in the study.

### *Algebra as Advanced Math*

Children and adults both generally, perceived algebra as a more advanced or complex type of math. As one respondent commented:

*[Algebra is] “way more advanced than adding and subtracting....”*

The lines between algebra and other types of math, however, were fuzzy for respondents. For children, in particular, the lines between different types of math such as arithmetic, algebra, or geometry were blurry.

### **Algebra descriptions**

*Algebra “uses letters and you have to...guess the letters...so if you did like 360 times X equals something you have to guess what the X stands for.”*

*Algebra is “like four plus two but you just add some more stuff to it. Like four plus two and then it’s like times one like plus three. Algebra you just add more like signs and numbers to it.”*

*When you’re trying to figure out “how far something is falling or how fast something is going you use an algebraic equation to get there. So it’s kind of the type of math we use to figure out life’s problems.” (adult participant)*

*Algebra is “the blending of alphas and numbers...The key to it is to do the multiplication first...If you follow the pattern you’ll get the answer. (adult participant)*

## Common Conceptions of Math and Algebra, cont'd.

Many participants saw algebra as a difficult type of math. Children and adults used words such as "hard," "challenging," or "complicated" to describe algebra.

*"Algebra made my brain hurt." (adult participant)*

*"Q: What kind of memories do you have about algebra class?*

*A: Frustration....just trying to figure out. Most memories I have of algebra class were problems a mile long."*

*"[Algebra] is very advanced, I think. [I did not take algebra but] I heard you have to really wrack your brain to learn it."*

### *Feelings about Algebra*

While not a main focus of this study, we did find that participants' perceptions of algebra as being difficult or more "advanced" led to some negative feelings about it. In survey data, 40% of respondents indicated they believed algebra was either a difficult subject for them or expressed negative feelings about it. Below are a sampling of typical

responses when participants were asked what came to mind when they heard the word "algebra,"

*"I hate that word."*

*"Hard math-"nooooooooooooooooooooooooo!"*

*"Makes me kinda nervous."*

*"I can't wait until class is over!!!!!!!!!!!!!!!!!!!!!!"*

On the other hand, some children in our interview sample indicated they enjoyed the challenge of solving algebra problems and liked it when they were able to get the right answer,

In general, however, the majority of respondents in this study saw algebra a complex and difficult type of math.

Interestingly, a 2004 Gallup Poll found that math ranked as a favorite subject among teens, but was also rated by teens as the most difficult school subject.

## Implications

Participants' conceptions about algebra were generally limited to the idea of "solving for x." Algebra was not perceived as a set of concepts or a way of thinking. Therefore, there is a big gap between respondents' conceptions and the algebraic thinking (patterns, etc.) that the exhibit wants to address.

The gap is important to address because visitors' current conceptions of algebra will not necessarily shift solely through fun interactives that engage visitors in algebraic thinking. In other words, visitors may not recognize what they are doing in the exhibit as algebra unless it is explicit.

A separate issue that the exhibit will have to address is the range of pre-existing exposure to and understanding of algebra.

## Common Conceptions of Math and Algebra, cont'd.

Participants, especially youth, often had difficulty describing algebra. In some cases, they “drew” their ideas of what algebra is. Their drawings reflect their limited understanding of algebra as being about letters and numbers and solving for the unknown letter.

A letter = a number and  
there are only 2 numbers and  
nothing else

$(X-2)=10$

$$\begin{array}{r} 11 \\ \div 7 \\ \hline ? \\ \cdot \end{array}$$



**Children talked about math in simple, everyday language.**

The block activity provided insight into participants’ “math talk.” During the block activity, participants’ conversations consisted mostly of references to **shapes** (such as “going in a circle” or making it “squarish”); **size** (such as making it bigger or doubling it); and **number of blocks** to be used. Only a couple children used slightly more formal math terminology such as area, perimeter and symmetry.

## Perceived Usefulness of Math and Algebra

### Overview

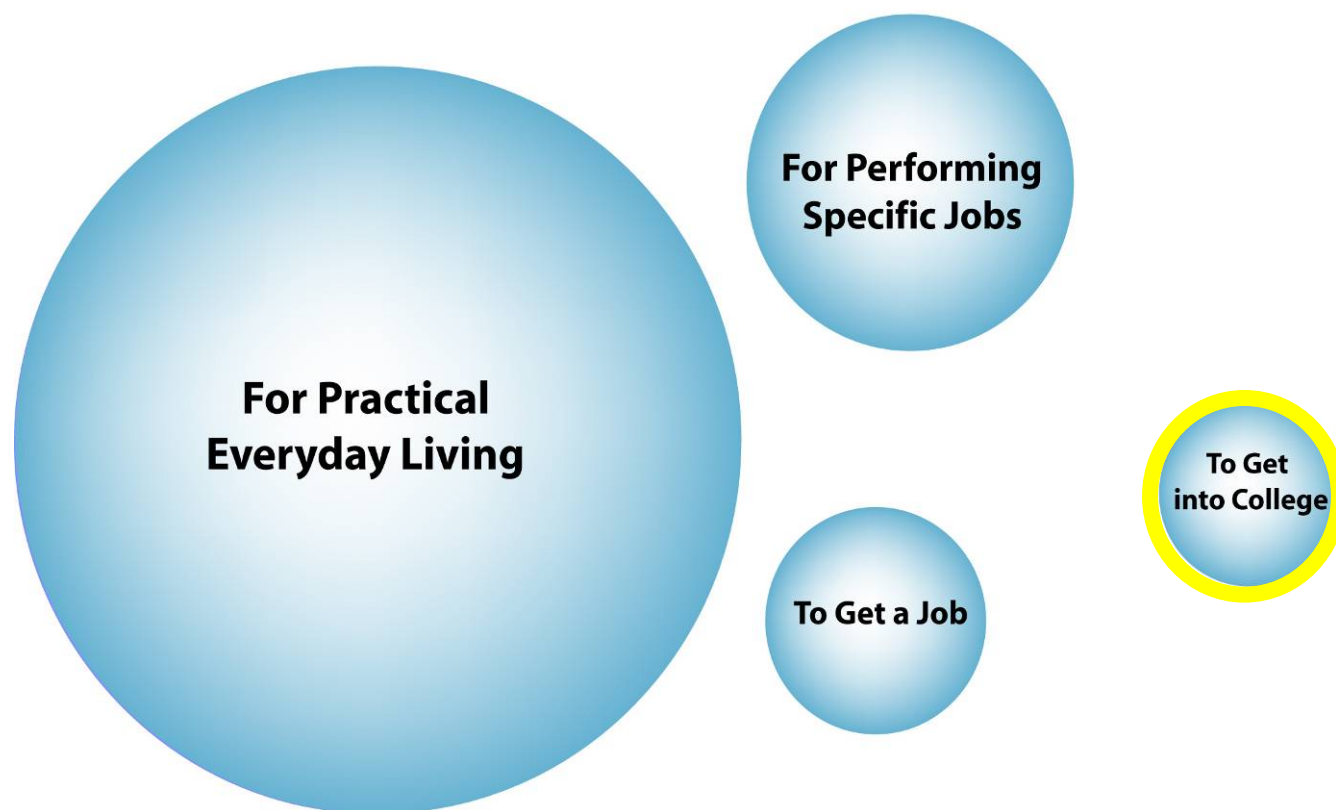
- Both children and adults saw math as something everyone uses in the “real world.”
- Math was seen as a critical skill and both adult and youth participants saw it as an important skill for daily life and also for the workplace.
- While participants said they thought algebra must be useful, they were generally not clear on how people use algebra in daily life.
- While participants said they thought people in the sample art/design jobs shown used math, their understanding of how such jobs used math was limited; respondents most often saw the math involved only in terms of using basic math skills (e.g., measuring).



Both adults and youth believed that math was used by people everyday, particularly for practical, everyday living.

## Perceived Usefulness of Math and Algebra

This graphic illustrates participants' perceptions of the usefulness of math in general and algebra specifically; the size of the bubble indicates the predominance of ideas named. Both adults and children saw math's usefulness primarily in terms of how it was used to do practical, everyday tasks such as making change at the store, cooking, or even doing taxes. Math was also seen as necessary for performing certain jobs or, to a lesser extent, getting a job or getting into college. Participants had difficulty articulating how algebra was useful; the bubble outlined in yellow highlights the most frequently stated reason why algebra was useful.





## Perceived Usefulness of Math and Algebra, cont'd.

### *Math in the "Real World"*

Both children and adults saw math as a critical skill and perceived math as something everyone uses in the "real world." The most common ways both adults and children talked about how people use math was for practical, everyday tasks, such as making change at the store, balancing checkbooks, building things, and cooking.

*"Math is something you need to function in life, like calculating percents when shopping"*

*"If you don't know math, you won't get anywhere."*

### *Math and Work*

Knowing how to do math was seen as a way to move ahead in life and was cited as important for getting into and graduating from college to getting a job—whether that job is at McDonald's or being a lawyer.

*"Like...you have to add up the money you get and you have to separate it evenly out to your employees to pay them and stuff."*

*"If you were going to like the grocery store and like say you ... added up to like \$8.30 and the customer gave you like this \$100 bill you've got to know what change to give them back."*

### *Algebra in the "Real World"*

Math in broad terms was generally easier for respondents to link to everyday living than algebra specifically. All participants were able to see how basic math (e.g., multiplication, addition) related to everyday life activities. On the contrary, algebra was usually explained in terms of equations without a direct link to any practical use.

Algebra, and higher math in general, were seen as a way to get into or graduate from college, but the focus was on "memorizing an answer needed for a test" rather than as a useful skill to be used later in life.

Both children and adults said they thought algebra must be useful somehow, but were usually not able to give clear examples of "real world" applications of algebra.

### **Perceived Usefulness**

Despite participants' statements that algebra must be useful, adults and children had difficulty articulating the reasons for how the careers shown might use algebra.

*"The depth, like for example the airplane, you've got to determine a lot of the things when it comes to the airplanes. You know the width... aerospace engineering they require more algebra than anything else. Because it would have to determine the speed, it would have to determine height, the weight, you would have to determine you know how light the material has to be."*

*"For the fashion designer how much bigger you want this garment to be on a large woman versus a small woman. You don't want to just double it. There is – somewhere there is some kind of formula to figure that out. Which there you go with a formula. Which is algebra."*

## Perceived Usefulness of Math in General and Algebra, cont'd.

While most said they believed algebra is used somehow, the *how* was largely unclear to them. Children, for example, commented that:

*[Algebra is needed for work but] "you don't know when you're using it."*

*"Algebra is involved in shopping when a price sign says two for one."*

Some adults did attempt to give specific examples of how they believed algebra is used in daily life. One participant, for example, said that figuring out how long it will take to drive from one place to another involves algebra because of having to take into account factors such as speed and distance.

Overall, however, participants' understandings of the applications of algebra in daily life were fuzzy. A major contribution of the exhibit can be to broaden visitors' conceptions of algebra and to see it as more than symbol manipulation.

### *How Much and How Many*

Respondents' perceptions of the math involved in the careers show was limited. Participants' conceptions of how these jobs used math can largely be categorized as looking at measurements and counts ("how much" or "how many."). For example, youth talked about architects counting screws or beams, fashion designers measuring length of fabrics.

*"[Architects] probably...see how big things are so you can build it. Like you can measure them and then build it. Because if you don't measure them you might take up too much space."*

*"[Aerospace engineers] would have to calculate how big the plane would be and how many miles it can go per hour or the speed limit....Pretty much how heavy it could be or how big these rockets can be that are hooked on to the plane."*

*"Fashion designer well again you know you're cutting up pieces and putting them together and they have to be measured."*

### Implications

Participants' conceptions of how they saw math applied "in the real world" were rooted in their lived experience (jobs, school, hobbies, etc.)—what they do every day. This was true for both adults and children. It will be important to contextualize math experiences in the exhibit (i.e., what will feel relevant to visitors based on their lived experience.) Tying an exhibit to a familiar experience and showing ways it is used in life can be a good entry point.

A quote from a parent—a builder who is also going to college—illustrates the difference between a contextualized experience and one that is too abstract

*"My favorite joke is I don't care that there's a train going to Chicago. I don't want to go to Chicago. I don't know anybody in Chicago. I mean, come on.... Math really came alive when I started applying it in carpentry. If somebody had shown me a tape measure I would have had almost no problems with fractions."*

## What makes an experience with math fun?

### Overview

- Math experiences were most frequently described as fun when they involved activities such as games, hands-on or physical activities, and/or used technology.
- Applying math to make or do something practical in life, such as building something, was also seen as a fun experience with math.
- Math was occasionally seen as an inherently fun subject by some, especially if the experience presented a realistic challenge.
- The people involved in a math experience—either collaborators or facilitators—also strongly influenced whether respondents perceived that a math activity was enjoyable.



Youth enjoy using math in everyday life activities such as cooking.



## What makes an experience with math fun?, cont'd

This study identified four main ways that participants described having fun with math. For a few respondents, the subject itself was compelling. In most cases, however, the experiences participants described involved other important factors.



### Subject

Math in itself was perceived as inherently fun.

- ☐ **Work with Numbers**
- ☐ **Find the Right Answer**
- ☐ **Enjoy a Challenge**



### Activity

The activity made learning math fun and interesting.

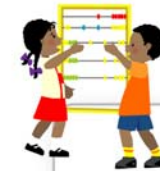
- ☐ **Play Math Games**  
(e.g. M&M math, matching activities, coloring)
- ☐ **Engage in Hands-on/physical activities**  
(e.g. using beads, food)
- ☐ **Use Technology**  
(e.g. computer)



### Application

Math was perceived as being fun if it was used to accomplish something fun in the real world.

- ☐ **Create Things**  
(e.g. building, cooking)
- ☐ **Calculate/count Things**  
(e.g. game scores, money)



### People

Using math was perceived as being fun when it involved working with peers and included effective leaders.

- ☐ **Collaborate with Others**
- ☐ **Learn from Good Facilitators**

## What makes an experience with math fun?, cont'd

### *Activities can make math fun*

Most youth described having fun with math when it involved an activity such as games, hands-on/physical activities or using technology. Respondents mentioned a variety of activities, some involving physical play.

One child, for example, described a game called Buzz Fizz: *"the class gets in a circle and then like you choose two numbers and if it's – if a number that you say is, like, a multiple of any of those two numbers you like say buzz. If it's a low number, the lowest number out of those two you say buzz. But if it's the highest number you fizz."*

Computer games were popular and many described using these, such as math.com, Spore and Plato. Computers and electronic devices have strong appeal to the target age range.

However, games can also backfire if not done well. One child, for example, described a Fun Brain computer game that tries to make math games fun but *"they blow it."* *"It was like a little bumble bee and you carry around the equation and you got to a flower and you pollinate it with the equation. It's really retarded."*

### *Using math can be fun*

Respondents also had fun with math when they were able to use it to accomplish something in the real world. They gave various examples of having fun using math in the context of creating something, such as baking or building.

One child, for example, talked about having fun building a clubhouse with sticks and figuring out the right lengths of wood to do it. One girl talked about how she had fun building a robot as part of a team that went to state finals, even though she generally did not enjoy math. A parent talked about how much she enjoyed gardening with her child and using math to figure out the spacing in a flower bed.

Respondents often contrasted these experiences with more traditional approaches such as math worksheets. One respondent, for example, said that solving a series of math problems on a work sheet is *"like 15 [pages] of nothing."*

**Math is fun when you can do something with it.**

*"Building things [using math] is interesting because you can make things come alive."*

*"Application is huge."*

### **Examples of fun math activities:**

- Playing games on math.com
- Running to a card with the right answer to an equation *"because you can run around and have fun instead of being in the classroom doing a piece of paper."*
- Measuring, counting and eating parts of a pumpkin

## What makes an experience with math fun?, cont'd

### *Math can be a fun subject*

A few respondents indicated they enjoyed math for its own sake, though fewer respondents talked about math this way. These respondents enjoyed the sense of accomplishment when they felt challenged and were the able to get the right answer to the problem. As one child put it, *"I like doing it because... when I see the numbers...the answer comes in my head."*

*"In the last month math has been awesome because...we're working on rephrasing fractions like say you have  $\frac{4}{8}$ ths, you can reduce it into one half."*

Conversely, respondents said they strongly disliked math when the challenge was too much and/or when they felt a sense of failure when they got the wrong answer. One child, for example said she dislikes being told *"oh, you failed math. You have to do it again."*

### *People can make math fun*

The social interaction of "doing math" with others also emerged as an experience that can make math fun.

Several groups of children, for example, said they had fun doing activities or playing games with others that involved math (e.g., monopoly)

Beyond the socialization aspect, there were indications that in some cases peer groups could help individuals better understand the math ideas involved. One respondent, for example, said she thought math is easier to understand when other kids explain it "in English." During the block activity for this study, in fact, we noted that interactions between youth were useful in helping the group "solve" the challenge.

Data also revealed that having a good facilitator could also contribute to "having fun" with math. We heard several examples of skilled teachers or adult facilitators whose approach and style made a difference in child's math enjoyment.

One parent, for example, described how her son now just does math because he has to do it as part of class, but when he had a teacher who used music to teach about math, "he'd come home and say 'Mom, I love math. It's fun.'" Two girls who said they no

### **Facilitators can make or break a math experience**

*"Part of the reason why I think [math is] scary is because my teacher is like ... the devil. He's sort of torturous."*

*"I used to be good at math and I used to love that subject...it was more easier for me because it's like some of the teachers...they explained it well and tried to challenge you and really help out and gave you lots of tests on it."*

## What makes an experience with math fun?, cont'd

longer enjoyed math, related memories of liking it better at a previous schools where they thought the teachers did a better job.

### *Other types of fun experiences*

Interviews revealed that youth in the target age range have fun with activities that allow them to express their creativity or where they can experiment.

Art was frequently mentioned as a subject respondents enjoyed. As one child put it, *"In art there are no rules. In math there are a lot of rules. In art you can't make any mistakes. In math you can."*

This same girl said "eew" when asked about math, yet she had a lot of fun creating three-dimensional designs with the pattern blocks because she perceived it as be about making art.

Science also emerged as an area of particular interest to youth respondents. They enjoyed experimenting and seeing (preferably dramatic) results, such as the cause

and effect of making a volcano explode, or melting chocolate bars.

Initially respondents did not necessarily see any math involved in these activities but upon further reflection, some said they could see a bit of basic math, such as counting the number of pieces needed for an experiment, or putting the right amount of liquid in to make the volcano explode.

### Implications

Respondents' descriptions of positive, as well as negative, experiences with math suggest multiple avenues for developing fun experiences with math. Creating hands-on activities is a tried and true method familiar to youth. However, presenting a "real world" application for math has the potential for creating deeper connections to the subject, rather than just a passing sense of doing a fun activity.

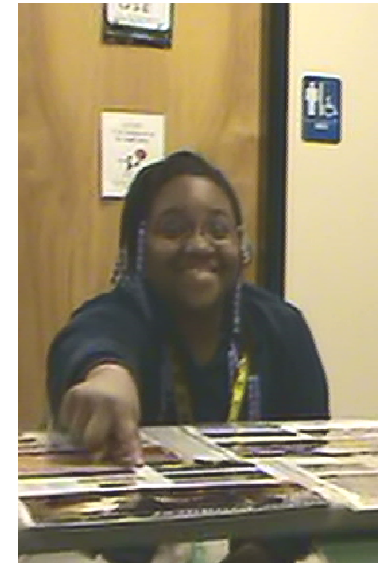
Regardless of approaches used, creating opportunities for collaboration and facilitation will enhance the experience. Some food for thought questions:

- How can the inherent fun that some find in math be conveyed to others?
- How can we give visitors a feeling of success rather than a fear of getting the wrong answer.?
- How can we make math experience more like the fun art or science experiences youth discussed?

## Responses to Proposed Approach

### Overview

- Exposure to different careers strongly appealed to both parents and children.
- When presented with a specific set of careers, a number of participants did not understand the day-to-day work of the jobs presented.
- Overall, respondents were particularly excited about the *products* made through different careers, rather than the job per se.
- Respondents generally stated that an exhibit focused on math/algebra alone would not be of interest. However, adults saw this as a path to getting youth excited about math/algebra. Both adults and youth were intrigued by an exhibit approach that focused on “cool” products made by people in the different jobs presented and were particularly interested in the idea of visiting an exhibit that provided opportunities to try out some of these jobs.



Youth enjoyed thinking about various careers presented and the interesting products produced.

## Responses to the Proposed Approach

### *Exhibit Approach*

Exposure to different careers strongly appealed to parents and youth; both were intrigued by the idea of learning more about particular careers. Youth saw it as a way to “try on” these careers and participate in activities related to that job.

*“Cool. [It] gives you a chance to try out different things for when you grow up.”*

*“[It gives] kids a chance to do what grown ups do [and see if they] like it--if they like it really, they might be [that as adults] if they try [it at the exhibit].”*

Parents, in particular, saw this focus as a way of expanding their children’s conceptions of what they could be in life. They saw it as a way to have their children learn more about a variety of career opportunities.

*“I even...like young adults or maybe new college students will say ‘you know why do I have to take all these math classes? I’m going to*

*school for this....’ Because they haven’t made the connection as to how it plays into what they’re doing. So that would be an awesome exhibit actually.”*

### *Interest in Products Made in Careers*

Participants—particularly youth—were interested in the jobs presented **because of what people in those jobs made or designed**—clothes, games, buildings—not because the career itself was seen as inherently interesting.

*“Well I think like you guys can have this exhibit where you guys show some awesome fashion design posters ...something and like design your own fashion outfit, like maybe design a T-shirt.”*

*“[I like the] music producer because I think I can sing. So I could make my own music and I could still be a producer. ”*

*“I like the [fashion designer]. Making clothes and being famous.”*

Online surveys followed up further on potential activities of interest to youth. The most appealing included:

### **A Music Producer Does What?**

Participants, both adults and youth, had difficulty assessing whether the sample careers presented used algebra. This was exacerbated by the fact that participants had little comprehension of what the job entailed in any detail.

Here are the most common ways participants identified people in jobs presented use math.

- Music producer: adjusts volumes on recording
- Fashion designer takes measurements
- Architect: measures and build homes
- Video game designer: uses a computer which respondents saw as inherently connected to math, although they could not name specifics.
- Aerospace engineers’ use of math was not clear to participants.



## Responses to the Proposed Approach, cont'd.

a) composing and recording a song; b) programming a robot and; c) designing a fashion line for t-shirts and cell phone covers. The table on the next page provides data online survey results.

### *Understanding of Careers*

When presented with a specific set of careers, youth and some parents did not necessarily understand the requirements and day-to-day work of the jobs presented. And youth, had little comprehension of what some of these careers actually entailed. As an adult recalled, *"I remember people when I was younger saying oh you should be an engineer. And I remember as a kid thinking well what's an engineer? What do they do?"*

The challenge will be making these jobs quickly understandable to visitors.

Additionally, the jobs presented were largely "white collar" and when taken as a whole, run the risk of being seen as making a value judgment about what jobs are worthy of highlighting. One parent, for example, suggested showing a

broader spectrum of jobs.

*"[Have] some more blue collar positions since a lot of people become blue collar workers...[for example]...in the architectural field [show a] construction worker."*

### *Algebra Content*

While there was a high interest in the idea of an exhibit approach that highlighted careers, both adults and youth were uncertain that an algebra exhibit could actually be fun.

*"I think they [youth] might not think it's fun because it's number one, math, and I guess not -- a lot of kids don't like math..."*

*"Find a way to keep their mind focused on the jobs and just ... they're paying attention to something else and you could tell them about the math part while they're paying attention to something else"*

There was some concern from youth about this as well.

*"I didn't really understand how we could talk about careers that involve math without letting kids know that there is math happening and math is [not really fun]."*

## Implications

Respondents were particularly excited about the products that are made by different people in different jobs. Thus, what makes a careers "cool" in youths' minds is not the job per se, but what they make that is "cool."

It may be useful to focus on the product and then use it as a jumping point for different art/design jobs that contribute to designing and making the product. This approach could then also provide opportunities to show a broad spectrum of jobs across education levels and how individuals in many different types of jobs use algebra in their everyday work.

Additionally, because the career/job piece was of high interest and reinforces the idea that algebra is used in the "real world," a post-visit experience could be the place where youth are given opportunities to delve further into learning about these careers.

## Boys and Girls Clubs Participants

Activities Ranked by Overall Preference	All Responses N=39	Female Only N=23	Male Only N=16
Compose and record your own song	44% (17)	43% (10)	44% (7)
Program a robot	44% (17)	35% (8)	58% (9)
Design a fashion line for t-shirts and cell phones covers	33% (13)	43% (10)	19% (3)
Morph a digital image of yourself	31% (12)	30% (7)	31% (5)
Test a model rocket	28% (11)	35% (8)	50% (8)
Design a house	26% (10)	39% (9)	6% (1)
Choreograph a dance	26% (10)	39% (9)	6% (1)
Create your own tile, fabric, or beadwork patterns	15% (6)	17% (4)	13% (2)
Invent a musical instrument	13% (5)	9% (2)	19% (3)
Program a light show	13% (5)	17% (4)	6% (1)
Test your speed and compete against others	10% (4)	0% (0)	25% (4)
Jam with an electronic drum set	5% (2)	0% (0)	13% (2)

## OMSI Participants

Activities Ranked by Overall Preference	All Responses N=50	Female Only N=25	Male Only N=25
Design a house	42% (21)	44% (11)	40% (10)
Program a robot	40% (20)	16% (4)	64% (16)
Test your speed and compete against others	36% (18)	24% (6)	48% (12)
Test a model rocket	32% (16)	12% (3)	52% (13)
Design a fashion line for t-shirts and cell phone covers	30% (15)	56% (14)	4% (1)
Compose and record your own song	28% (14)	48% (12)	8% (2)
Program a light show	18% (9)	8% (2)	28% (7)
Jam with an electronic drum set	18% (9)	16% (4)	20% (5)
Choreograph a dance	16% (8)	28% (7)	4% (1)
Morph a digital image of yourself	14% (7)	12% (3)	16% (4)
Invent a musical instrument	14% (7)	16% (4)	12% (3)
Create your own tile, fabric, or beadwork patterns	12% (6)	20% (5)	4% (1)

## Gender Differences

While there were relatively few gender differences identified in youth preferences on proposed careers (except for the fashion designer job which was perceived by boys as being for girls), survey data revealed potential differences in preference in proposed activities both between genders as well as between Boys and Girls Clubs and OMSI testing locations (or demographics).

This supports existing literature regarding interests between males and females. The differences between responses at the Boys and Girls Club compared to OMSI could be investigated in further detail.



## Responses to Proposed Approach, cont'd.

What makes careers “cool” for youth in this study is that what they make is “cool”. When shown images of particular careers, children connected strongly with the end products of those careers. For example, the game designer was linked to video games, fashion designer was associated with the clothes designed, and an architect with the completed building/house.



## Parent Perspectives: Working with children on math

### Overview

- Parents are motivated to help their children with math because they see it as an important skill for success in life.
- Parents actively seek out “real world” opportunities to teach children math skills.
- Most challenges in supporting their children’s math learning centered on homework/school.



Parents wanted their children to know how to use math to handle and manage money.

## Parent Perspectives: Working with Children on Math

### *Parental motivations*

Parents in this study perceived math as important for their children in order to succeed in life both in work and in performing day-to-day skills such as balancing a checkbook. They enjoyed it when they could help develop and support their children's math skills. Caregivers shared feeling a sense of satisfaction from seeing their children master math skills and they also tried to reinforce math's importance to their children.

*"I get a great pleasure out of seeing him do well [in math] too and I want him to be able to apply math."*

*"I try to explain to her why math is so important....[I]f I didn't have skills in math I would not be – I wouldn't perform well in my job. So I try to put it to her in that aspect, you think it's just boring numbers and why do I have to learn this but when you get older you're going to thank me that you know this stuff."*

*"Once it clicks then it becomes fun because now it's like they've gotten over that little hurdle."*

Parents also tried to strike a balance between helping their children with math and letting them problem-solve on their own.

*"I try to make him think without giving him the answer."*

*"I don't want to help them so much that I'm doing it for them."*

Parents actively looked for real world opportunities to teach their children math skills (e.g., making change at the store). Showing their children how to use math to manage money was a recurring theme among parents' conversations with researchers.

*"I make them find the cheapest whatever at the grocery store on a regular basis."*

*"I wanted her to learn how to count back from the change to the dollar bills to the largest bill. And that was one of the things she had to learn last year. Her motivation for that is there's a tip jar. If she learned what she was supposed to learn she got to keep all those tips for the whole summer."*

### **Challenging children to use math in the real world**

One parent talked about how she challenged her daughter to figure out how much money she would need to deposit and then earn to buy something she really wanted.

*"There was something she really wanted at a local store and it was rather expensive. It was like \$127....[T]he owner came around and [said] we also have a lay away plan. And it's just a very simple 20% down and then...you pay any amount every month...you can take it home when it's paid off."*

*So [I asked] how much money do you need to have if you put down on this? And then you know working through chores..you could pay off the rest over the course of the summer. And how soon you get it would be dependent on how hard you work. And but also in thinking of the actual percent of you know \$127, the actual 20%, well let's estimate the percent also."*

## Parent Perspectives: Working with Children on Math, cont'd.

### *Parental challenges*

Most of the challenges parents expressed in supporting their children's math learning centered on homework issues. In particular, the math approach used in school was sometimes different from parents' experiences when they were in school, making it difficult to assist their children. As one parent put it:

*"I guess something else that kind of makes it a little bit challenging at times is they teach math differently than they did when I was a kid. And so a lot of times the homework that she gets at home, they're allowed to use calculators now for their homework, for their math. And you know it's more about how to solve the problem rather than solving the problem. And I don't quite understand that too well."*

Sometimes the homework was at a level beyond a parents' knowledge or what they remembered. Parent at times expressed frustration, sharing stories of homework sent home with insufficient explanations, undefined math terms, or lack of context.

*"Because I mean the books that he brings home now really don't tell you how to do it. It just gives you something brief and...one example."*

*"[W]e had to actually go online and look up the definition for some of these terms so just to bring it back to me so that I could help her."*

One parent explained that he wanted to know what is being taught in class and at what pace *"because I think sometimes I jump way ahead."*

*"Well right now since they're still in elementary school it's pretty easy. It's not as complex as it would be if they was in senior high school. Then that's when I would be very, very stressed and very worried."*

### **Implications**

Findings suggest that parents may have difficulty helping their children with understanding the algebra content in an exhibit. For many, their own understanding and/or memories of algebra will be limited.

While we often assume that parents will be the ones that facilitate their children through exhibit activities and challenges, this may not be a realistic assumption in this exhibition given that parents' perspectives and knowledge may be similar to youth. The team will need to decide what role a parent can be expected to play in the exhibit experience. An appropriate role may be to think of parents and youth as collaborators.

Additionally, the practical use of math was a recurring point of interest for both parents and youth. This raises the question of whether there is a way to use this as an entry point for the exhibit.

## RECOMMENDATIONS

- Participants' conceptions about algebra were limited to the idea of solving for  $x$ . Therefore, there is a big gap between respondents' conceptions and the algebraic thinking that the exhibit wants to address. The gap is important to address as solely having fun with interactives that engage someone in algebraic thinking will not necessarily mean visitors will shift their current conceptions of algebra.

On the other hand, both youth and adults expressed some reluctance about an exhibit focusing on algebra. The challenge will be striking the balance between making the algebra obvious and integrating it seamlessly into an enjoyable activity.

- An on-going discussion among the team has been what is meant by "algebraic thinking" and what specific concepts the exhibit will present. The team should consider selecting just a few key concepts to focus on rather than a large array of algebraic ideas.

If possible, it may be useful to present the same concept at varying levels so that it is accessible to varied ages and experiences with algebra.

- Focusing on the ways algebra is used in various jobs/making products seem to be a very promising direction both because of its appeal and also because it can highlight its use in the "real world," which was important to parents.
- Given that adults' conceptions of math and algebra generally were not significantly different than older children's, findings raise the question as to what the best role for parents is in the exhibition. Is it facilitator, peer, collaborator? Findings indicate that the traditional "facilitator" role we often assume adults automatically take on in an exhibit experience may not be the best fit. The team will need to consider social interaction among a group and what role parents can best take on in the exhibit.

## References

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## APPENDIX: RESPONDENTS

### Participants by Gender

	Female	Male	Total
Youth	15	12	27
Adult	10	2	12

### Youth Participant by Age

Age	Total
Age 10	11
Age 11	8
Age 12	3
Age 13	3
Age 14	2