Partner, Advisor, and Consultant Meeting
A Formative Evaluation Report

Prepared for

OMSI
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Access Algebra Project
Partner, Advisor, and Consultant Meeting
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Formative Evaluation Summary

Introduction

From December 2008 through May 2009, OMSI was engaged in the formative evaluation stage for the Access Algebra project and the *Design Studios* exhibit. Over this period, 15 prototypes were created and tested with OMSI visitors. With these prototypes, multiple evaluation activities were conducted.

- Rapid prototype testing with OMSI visitors
- Focused testing with youth from the Blazers Boys & Girls Club of Portland (BBGC)
- Professional graphic panel review
- Facilitation testing with OMSI staff and visitors
- A focused furniture study
- Family night "sneak preview"

With this mixed-method approach, the team was able to identify successful strategies for engaging visitors with algebraic thinking and promote math-talk.

Overview of Methods

Rapid Prototype Testing
With this method, generally one prototype was tested at a time. We used naturalistic observations and post-use interviews with OMSI visitors who used the exhibit. These interactions were unprompted and unfacilitated. In contrast to more traditional prototype testing, which can take several days and necessitates larger samples, rapid prototyping strives to test multiple iterations quickly and efficiently. Most exhibits were tested over one day and sample sizes were smaller, which leads to more qualitative data rather than quantitative analysis. Three staff members observed and interviewed visitors rather than the usual one staff member. Having more "eyes on" helped to identify barriers and potential solutions quickly.

The method is more responsive than traditional methods with opportunities to make changes on the fly. Often options were built into the hardware or software for multiple variations we were hoping to test with visitors. Midday updates (for graphics) and end-of-day express reports gave rapid feedback to the developers, designers, and production team to allow them to move forward quickly.

Focused Testing at the BBGC
For this study, we brought five prototypes to the BBGC. Over two days we were able to get feedback from our underserved audience, see a group of prototypes together for the first time, and see how the elusive teen audience (13- to 15-year-olds) would react to the exhibits.

At the club, the youth were recruited to participate and paired together. At each prototype they had the opportunity to give OMSI staff feedback. After they had used all five prototypes, the youth were split into two groups and participated in a focus group.

Professional Graphic Panel Review
Several graphical styles had been tried on these five prototypes. In order to help guide the team on which direction to follow, the Garibay Group conducted a graphical panel review. Results from this review were used in subsequent iterations of the graphical layout, design, titles, hierarchy, challenge labels, data sheets, instructions, "connections" panels, and style.

Facilitation Testing
Throughout the formative phase, the professional development team worked in tangent to the exhibit development team in reviewing exhibit prototypes and offering feedback on how to make them more facilitation friendly. Six exhibits were identified for explicit prototype testing with the addition of a facilitator. These activities had several purposes: to determine how effective various characteristics of the physical prototypes were in helping the facilitator to engage with visitors, to determine strategies the facilitators could use to engage visitors in math-talk and algebraic thinking, and to determine how effective the training was that the facilitators received.

Furniture Study
In order to determine the effect of seating and the environment around an exhibit, a comparative study was conducted on one of the prototypes. The exhibit was observed both with and without furniture (couches, chairs, and foliage) and the relative engagement and math-talk were compared.

Family Night
The final formative evaluation activity was the family night sneak preview of the exhibit. All fifteen prototypes were set up and 50 families visited the museum over two nights to experience the exhibits as a whole. Half of the visitors were members and half from low socioeconomic status families. These groups were observed over their 35- to 40-minute interaction with the exhibit and then interviewed for their perspective on the exhibition, including the main message.

Results
Through these methods and with the opportunities for multiple iterations, we experimented with and discovered several characteristics that proved to be successful in engaging visitors and eliciting math- and algebra-talk and behaviors. We were successful in the following:

- Engagement—we observed long dwell times (2+ minutes) and rich hands-on interactions. There was excitement, enthusiasm, and/or contemplation among visitors. Examples of engagement: hands-on activity, helping each other, competing with each other, asking questions, answering questions, etc.
- Age-appropriateness—visitors in the target age range (10–14) enjoyed the activities and were interested in using them. Typically ages 8 and up were able to enjoy the exhibits and be successful with them. Younger visitors (under 8) often were less able to interact with or take away messages from the exhibit. Older visitors (15–21) (who are rare) seemed to have extended engagements as well.
- Family learning/facilitation—we saw peer group participation and adult facilitation in family groups. Parents could read the connections copy and help to scaffold the children's learning. We saw various types of parent/child interactions such as the parent following directions from the child, the parent directing the child, collaboration, and explanation.
- Math-talk and algebraic thinking skills—families were using algebraic thinking skills and using mathematical language in their interactions with the exhibits.

  Math-talk came in the form of: suggestions, questions, comparisons, doing arithmetic, making an observation about one or more of the variables at an exhibit ("look at how wavy the line is"), or talking about a relationship in the exhibit explicitly ("the number of wheel turns is the same").

  The math-talk we did hear generally fell into two categories: "qualitative" and "quantitative." Qualitative math-talk would not include numbers but would focus on relative relationships ("this one is heavier" or "move this further out"). The quantitative math talk would be more explicit ("you have to add five more" or "2x6 is 12 beats").

  Math-talk was influenced by group composition and age. For example younger visitors (8–12) were more qualitative in their math-talk while older (13+) were more quantitative. Also the presence of an adult facilitator (parent or chaperone) improved the quality of their math-talk and tended to make their talk more quantitative in nature.
- Communicating messages—our visitors understood both the messages of the individual exhibits and the overall message of the exhibition as a whole.

Our strategies for eliciting these behaviors and interactions can be categorized in three ways: copy panels, exhibit layout, and exhibit characteristics.

Copy Panels
Our most successful exhibit labels had a consistent design and style focusing on six aspects. A wide variety of strategies with the various labels/copy on the exhibits were tried and the following list represents the teams' current best thinking with regards to engagement, fostering math/algebra-talk, and family group participation and facilitation.

- Design: The copy panels had a consistent and contemporary look and feel. This included brighter colors, active images, particularly with respect to near-peer

imagery, and relevant images. Relevant images make clear connections to the target audience's experience and interest.

- Labels: The labels had a consistent hierarchy of information (font size/location), a reduction of the amount of information on each copy panel, and explicit examples or instructions or explanations. Visitors tend to take examples and directions very literally so they can't be ambiguous.
- Exhibit Titles: Titles convey what the exhibit is about and orient visitors. For example, the "Make a Mobile" was not relevant to the youth at the BBGC so the title was changed to "Balancing Art."
- Challenges: Challenges give visitors a direction to take their exploration if they want (rather than open-ended exploration). Target audience members in particular enjoy challenges as a means of engagement. Our challenges help to direct the interaction away from what commonly happens, like trying to go the fastest/farthest/longest, and more towards exploring how to manipulate variables to get a desired result, for example.
- Connections: All exhibits have a "connections" copy panel, specifically directed towards the parent/facilitator of the group. This copy gives the adult the information they need to help make the connection to math and algebra. Three types of connections copy were experimented with at family night: a loose career connection or connection to daily life, specific algebra within the exhibit interaction, and broadening visitors' ideas about what algebra is in general. The connection panels are not yet completely effective—parents had some difficulty with them.

Common throughout is the need for relevance/personal connections in imagery and examples. Currently there are three consistent labels on each exhibit: title, challenges, and connections copy.

Exhibit Layout
The exhibits were multi-sided to allow multiple visitors to cluster around the exhibits and often multi-user to let people collaborate in their engagement. Multi-user and multi-sided helps family groups or peer groups to interact together. Large screens were used where appropriate on computer-based exhibits. In other instances, multiple stations or two-person interactions (something we usually avoid) were tested.

The challenge copy was located prominently to draw the visitor's attention and guide his interaction. There was an effort to make the exhibits immediately apprehensible so few instructions were needed. Computer interactives that were more complex had brief tutorials to familiarize visitors with the interface before they started on the challenges. The connections copy was oriented in such a way that it would be easy to read from a facilitator's point of view, often to the side of the exhibit. The amount of copy and the font size made it easy to read and interpret.

In the furniture study, adding furniture elements to the prototype increased engagement times and math-talk, especially for family groups. Levels of collaboration and math behavior, including success with the prototype challenges, were similar between the two prototype versions. Integrating comfortable seating with some exhibits may be a promising strategy for fostering algebraic thinking, especially when hands-on collaboration is not essential.

Exhibit Characteristics
In order to draw out the mathematical language and interactions from the visitors, we incorporated several characteristics in the exhibits. Data sheets, though not frequently used, lead to richer, quantitative experiences and a greater understanding of the algebra or relationships within the exhibits.

Limiting the objectives of each exhibit also helped to focus the interaction and was more likely to allow visitors to be both successful and understand the relationships they were exploring at the exhibit.

Incorporating quantitative characteristics in the exhibit, such as scales, number lines, weights, etc., provoked visitors to talk about the exhibit in these mathematical ways. All the exhibits had visitors explore patterns, relationships, and/or make predictions. The quantitative characteristics helped them to be exact, explicit, or numerical about these explorations.

Having various levels of challenges let visitors find their own comfort level. Teens in particular enjoy being challenged. The trick is to find the right balance between too hard (frustrating) and too easy (boring). By having multiple challenges, visitors can find their appropriate level and feel successful and satisfied. Additional open-ended challenges or questions, where applicable, help to extend the experience for those who like to go deeper.

Personal connections helped to make the exhibits relevant to the visitors and to be more interested in the results and the interaction. As mentioned above, in the copy and label section, having the exhibits themselves be relevant or have the personal connection is particularly important to the target age range. For example, the choice of instruments in the "Rhythm Tracks" (hip hop) made the exhibit more appealing to the target audience (and the underserved audience in particular) than other instrument choices would be (such as the flute and accordion in the "Algebra Synthesizer").

Staff Facilitation
Staff used a variety of successful strategies to facilitate algebraic thinking for visitor groups at the prototypes. These included providing starting points and challenges relevant to the mathematics, focusing visitor attention on one or two important quantitative relationships, and emphasizing relationships between quantities rather than arithmetic. The facilitation testing also highlighted a number of challenges, including facilitating collaboration and social learning at some prototypes, asking visitors to verbalize their thinking process, and maintaining a facilitator versus a "math teacher" role. Exhibits were better at supporting staff-visitor interactions when they included clear challenges focused on the mathematics, facilitator-only extensions, and physical layouts that provided space for both the facilitator and the visitors to comfortably interact.

Summary
We experimented with a variety of approaches. We learned from all the activities we conducted. We were able to apply lessons learned throughout testing to each subsequent prototype and even to go back and modify the existing prototypes to incorporate these improvements. This all lead to very engaging and successful results at our sneak preview. Visitors used both qualitative and quantitative math-talk comfortably and easily while being aware that the exhibit was about math and algebra.