

# *Cyberchase*

## **Season 5 Pilot Summative Research: Quasi-Experimental Pilot Test**



### **Executive Summary**

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## Executive Summary

To inform the design of a planned major study of children's learning from multiple media (using materials from the mathematics series *Cyberchase*), a small-scale, quasi-experimental pilot study was conducted with 47 children in the third and fourth grades. The pilot study was intended to accomplish two primary purposes:

- To provide a context for developing measures to assess change in children's mathematical problem solving and attitudes toward math, as well as empirical data to test the reliability, validity, and usefulness of these measures.
- To serve as an initial exploration of children's learning from multiple media. We did not expect to find statistically significant results, due to the small sample size. Yet, the data were intended to reveal trends that would inform the creation of empirically based hypotheses to be investigated in greater depth during the planned full study.

A brief summary of the outcomes of the pilot study regarding each of these purposes is presented below.

### **Developing Measures of Problem Solving and Attitude**

Drawing on the research literature and consultation with experts in the field, we developed a battery of measures to assess problem solving and attitudes toward mathematics:

- Our approach to problem solving was based in the notion of "thought-revealing activities" described in the literature on mathematics assessment – that is, rich, meaningful problems that are relatively open-ended, can be solved in multiple ways, and require students to create their own strategies and intellectual tools for working on the task. Our measures of problem solving assessed children's performance in several thought-revealing activities, with three of the activities administered as hands-on tasks, and four as paper-and-pencil tasks.
- Two types of measures were used to assess attitude. One type was a set of three self-report rating scales (regarding interest, confidence, and pursuit of challenge) that were administered in both the pretest and posttest. These scales reflected interest, confidence, and orientations toward pursuing challenge, respectively. Additionally, in the posttest only, we administered two open-ended paper-and-pencil measures. One of these asked children to write about a time when they had to use mathematics to figure something out, and the other asked them to draw a picture of someone using mathematics. Both of the open-ended measures were intended to reveal children's constructs of what "math" is, as well as aspects of their enjoyment of mathematics and willingness to pursue challenges.

- We used empirical data from the pilot study to test these measures for interrater reliability, external validity, and (in the case of the attitude scales) internal consistency among items. In addition, we also examined the data qualitatively, to evaluate the degree to which each measure yielded data that were not only reliable and valid, but also potentially useful for the planned full study. Overall, the measures proved to be strong, and will serve as useful tools in the full study. However, the pilot data also were valuable in revealing a few instances in which revisions will be useful, for example, to eliminate redundancy among questions in some of the problem-solving measures, or to overcome response biases in some of the attitudinal measures.

### **Experimental Data**

The pilot study included a three-week treatment period, during which children were divided into three treatment groups: *TV Only* (children were shown three episodes of the *Cyberchase* television series per week), *All Materials* (children viewed the same TV episodes and also engaged in *Cyberchase* Web games and hands-on outreach activities), or *Nonviewers* (children were not shown any *Cyberchase* materials and viewed episodes of the American History series *Liberty's Kids* instead). A pretest-posttest design was used to compare children's problem-solving performance and attitudes toward mathematics before and after the treatment.

### **Problem Solving**

- Although we did not expect significant pretest-posttest differences due to the small sample size, nearly all of the measures produced nonsignificant trends that confirmed our expectations. Typically, one or both of *Cyberchase* groups (TV Only, All Materials) showed some measure of gain from pretest to posttest, whereas Nonviewers demonstrated less growth or even a decline. Notably, despite the small sample size, a few of these trends were strong enough to attain marginal or even full statistical significance.
- This pattern of results held true for both process scores (reflecting the number and variety of heuristics that children used while working on a given task) and solution scores (reflecting the mathematical completeness and sophistication of their solutions). In addition, comparable trends were found for several key heuristics: standard and nonstandard measurement (i.e., with and without a ruler), and looking for patterns (which, in this case, typically reflected finding and/or using proportional relationships among body parts to draw inferences about size).
- With an eye toward the future full study, the outcomes of the problem-solving assessment were very encouraging, in that they indicated that significant differences are likely to result from children's use of *Cyberchase* materials. The present sample size made it more difficult to detect consistent differences between

the two *Cyberchase* groups (TV Only and All Materials). However, the more extensive treatment and much larger sample planned for the full study should provide a richer and more effective data set to probe this issue in greater depth.

### **Attitudes Toward Mathematics**

- Like our analyses of problem solving, the three attitude scales revealed several nonsignificant trends in which the two *Cyberchase* groups (TV Only and All Materials) performed differently than Nonviewers. Yet, unlike the gains seen in problem solving, the attitude scales more often showed sustained positive attitudes among the *Cyberchase* groups while the Nonviewers' scores declined from pretest to posttest (or, in some cases, the scores of the *Cyberchase* groups declined less than Nonviewers'). We cannot be certain why the trends took this form, but this finding is not uncommon in evaluations of the attitudinal impact of educational television; similar patterns were found in evaluations of the mathematics series *Futures* and in some of the measures of motivation and enjoyment that were used to assess the impact of *Square One TV*. Perhaps these declines might stem, in part, from novelty and/or ceiling effects in the pretest, with *Cyberchase* helping to sustain children's enthusiasm and positive attitudes after the effects of novelty have worn off in the posttest.
- Specifically, all three treatment groups declined significantly in challenge scale items that reflected extrinsic motivation (e.g., wanting to figure out things that are easy, so as to avoid mistakes). However, only the Nonviewers showed a meaningful decline in challenge scale items that reflected a more educationally valuable intrinsic motivation (e.g., wanting to figure out things that the child will learn from, even if it entails making mistakes).
- Similarly, in the interest and confidence scales, all three groups showed declines in items that were not related to mathematics. However, Nonviewers showed greater declines in items that were related to either: the mathematics content of *Cyberchase* materials used in the treatment, other mathematics content that was not included in the treatment, or (in the case of the confidence scale) mathematics in school.
- Data from the writing and drawing measures proved to be of more limited usefulness, because they appeared to be constrained by children's pre-existing response biases and misconceptions. Prior research has shown that children's conceptions of "math" are often limited to basic operations involving numbers and arithmetic, rather than a broader and richer range of topics. The same was true here, which limited the opportunity to find meaningful differences among groups regarding children's constructs of mathematics.
- Response biases and ceiling effects were also at work in the affective dimensions of these two measures, in that most children's responses reflected positive affect

and very few mentioned difficulty. These factors severely limited the opportunities for differences to emerge.

- Looking toward the full study, the three attitude scales indicate that differences in attitude are likely to emerge among the treatment groups, but some of the benefits of exposure may lie primarily in sustaining pre-existing positive attitudes toward mathematics. In designing assessments for the full study, the attitude scales and open-ended measures should be revisited to determine whether adjustments can be made to overcome ceiling effects and response biases, or whether new or additional measures might be necessary.

Taken as a whole, then, the pilot study proved to be extremely valuable in several ways: (1) It provided an opportunity to develop and validate measures for the planned full study. (2) Our experience in the pilot study will inform the experimental approach and design of the treatment to be used in the full study. (3) The data from the pilot study provide an empirical basis for establishing reasonable hypotheses for the full study.

When combined with our previous pilot activities (i.e., literature review, expert consultation, evaluation summit, survey of outreach providers), the pilot study provides a firm foundation on which to build the full study that will follow. The present study will help to ensure that the full study will employ empirically-based hypotheses, valid and reliable measures, and a proven research design.