Evaluation of Cyberchase Phase One Pilot Study

Submitted to
WNET Thirteen

by

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EXECUTIVE SUMMARY

A pilot study of five programs in the Cyberchase series was conducted in late Fall, 2001. The study was designed to assess the broad educational value, impact, and appeal of the series, and to pilot the approach and instrumentation for a more extensive study in the spring of 2002. The study included more than 450 children and 20 teachers in the San Francisco Bay Area, encompassing the diversity of this region. The major findings of this study are presented below:

- **Both the children and teachers were enthusiastic about the appeal and value of the programs.** The children were engaged by the characters, story, and content. Teachers believed the series supported math instruction in the third and fourth grade classrooms, even though the series is designed for out-of-school viewing.

- **Attitudes about doing math improved significantly after viewing five episodes of Cyberchase.** Children's attitudes improved, to a statistically significant degree, across grade level, gender, and all four ethnic groups.

- **Self-confidence about solving math problems improved significantly after viewing Cyberchase**. Children's self-confidence improved, to a statistically significant degree, across grade, gender, and all ethnic groups.

- **Children's awareness of the scope of math tended to show an increase after viewing Cyberchase.** Although not statistically significant, there was evidence that the children's awareness of math broadened after viewing Cyberchase.

- **Content knowledge about math improved significantly after viewing Cyberchase**. For each of the individual programs viewed, content knowledge improved, to a statistically significant degree, for all groups represented.

- **Our study suggests that this series will appeal to and positively influence children's attitudes, self-confidence and math content knowledge.** We found no notable differences in the results between boys and girls, between third and fourth graders, and among the various ethnic groups in our sample. Our findings support that viewing Cyberchase had a positive influence on children and their engagement with mathematics ideas. This study was less comprehensive than the one to be conducted in the spring, one that will include broadcasts, a website, and print materials for both children and their parents.

These findings are further developed in the next section.

Summary of Findings

Overview of the Study

Cyberchase is an animated math adventure series for television that uses dramatic adventure stories to inspire an interest in and appreciation for mathematics among eight to eleven-year-old viewers, and to introduce them to important mathematical tools and problem solving strategies. The shows close with short, live-action segments that link the math topics to children's every day lives.

Children in this study viewed five episodes of Cyberchase that covered the math topics of navigation, estimation, area, fractions, and surveys. The episodes were distributed with a Pretest, one Posttest per episode (given immediately after the tapes were shown), and an aggregate Posttest (given a week after the fifth episode was shown). The true/false, multiple-choice and open-ended questions on the Pretest and Posttests were grouped according to the research questions, and were compiled into composite indices. In this summary the scores were transformed so that a higher score reflects a more positive attitude, awareness, self-confidence or content knowledge.

Sample

This study was conducted with 465 third and fourth graders in twenty classrooms in the San Francisco Bay Area during a three-week period in late October 2001. The sample was well balanced between girls and boys, and between third and fourth grades, and representative of African-American, Asian-American, Caucasian, and Hispanic students. The sample is detailed fully in Volume II.

Attitudes

After watching Cyberchase, the children showed an overall and statistically significant positive change in their interest in and attitudes about doing math. Both 3^{rd} and 4^{th} graders showed an increase in positive math attitudes (Figure 1, on the following page). Both girls and boys showed an increase in positive math attitudes (Figure 2, on the following page). African-American, Asian-American, Caucasian, and Hispanic children also all showed a statistically significant increase in positive math attitudes (Figure 3, on the following page).

Figure 1
Math Attitude by Grade

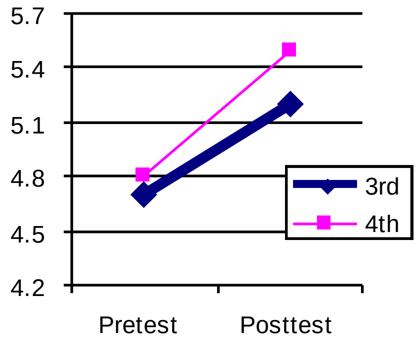


Figure 2
Math Attitude by Gender

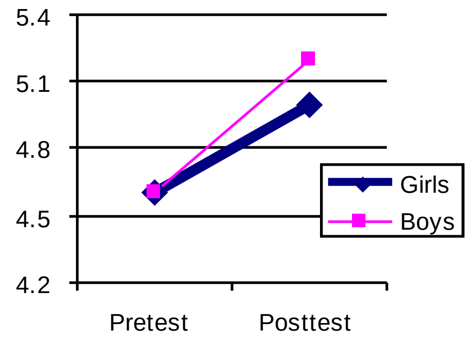
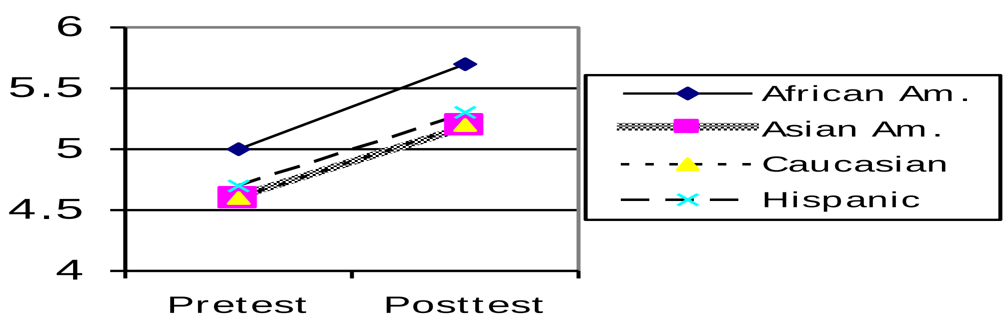


Figure 3
Math Attitude by Ethnicity



Each of the ethnic groups showed about the same increase in positive math attitudes, which may reflect the diverse nature of the program characters. Children's attitudes about liking and doing math improved, which suggests that the programs presented role models who themselves have positive attitudes about doing math-related things.

Most of the teachers said that children in general need a variety of ways to learn and understand new skills, and that this video series with the short live-action segments that link the math topics to children's every day lives could be a valuable addition to the cross-curricular math learning process.

Self-Confidence

Children felt more confident about their ability to solve math problems after viewing Cyberchase; this change was statistically significant. Both 3rd and 4th graders (Figure 4), and girls and boys (Figure 5) showed a statistically significant increase in self-confidence about problem solving skills.

Figure 4
Problem Solving Self Confidence by Grade

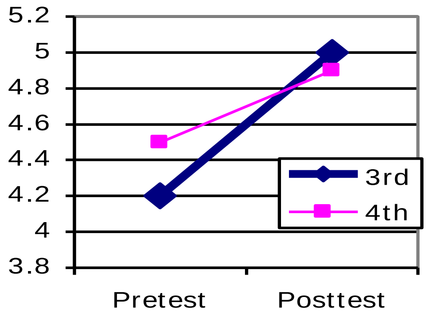


Figure 5
Problem Solving Self Confidence by Gender

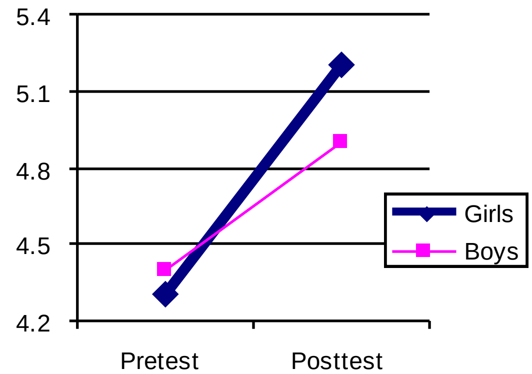
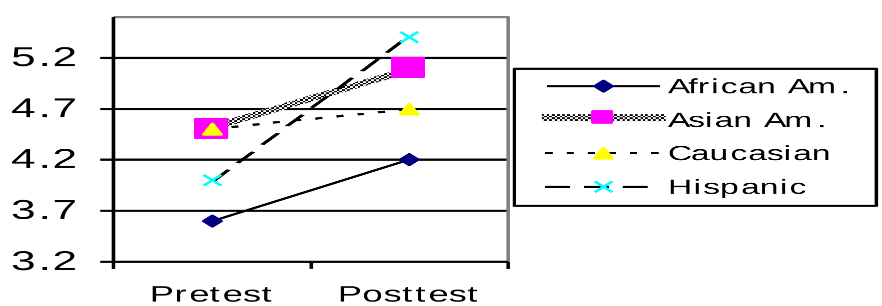


Figure 6
Problem Solving Self Confidence by Ethnicity



An analysis by ethnic groups also showed a statistically significant improvement across groups (Figure 6, above). Hispanic children showed a stronger increase in self-confidence: it is not clear if this is a regional phenomenon or attributable to other factors. This should be explored further in phase two of the study.

"I liked the fact that the girl characters were strong in mathematical concepts. Many girls in my class are afraid of math

already (very sad) and lack confidence. Good role models." - teacher participant

Math Awareness

Math awareness reflects how broadly children define "math", and what kinds of activities children see as being related to math, such as building a kite or baking a cake. We found no overall statistically significant difference between the Pretest and Posttest for children's awareness of the scope of math. We did find a trend towards a broader view of math, as shown in the following charts. These trends may show up more strongly with increased exposure to the programs.

Figure 7
Awareness of Math by Grade

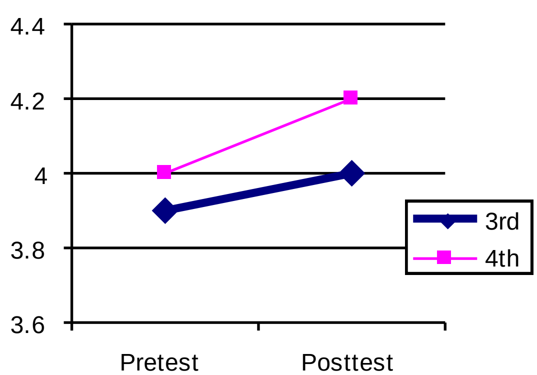


Figure 8
Awareness of Math by Gender

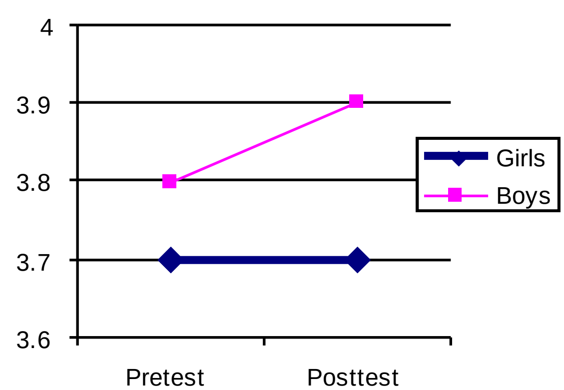
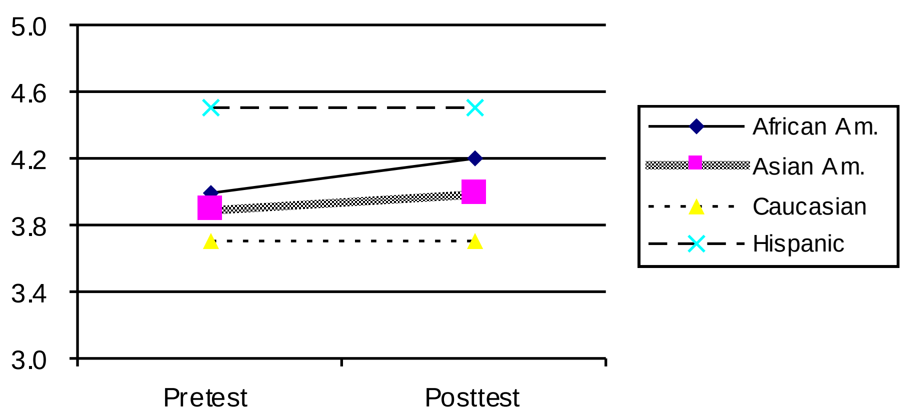


Figure 9
Awareness of Math by Ethnicity



"The [children] enjoyed watching [Cyberchase] "instead" of math. Had the attitude that this was entertainment." - teacher participant

Content Knowledge
We looked at the content topics presented in each of the five Cyberchase episodes viewed and found that, for each program, children learned elements of the content presented. The difference was statistically significant for the sample as a whole, as well as for grade level (Figure 10), gender (Figure 11), and ethnicity (Figure 12). Caucasian and Hispanic children showed a slightly greater increase in content knowledge. It is not clear if this is a regional finding and, therefore, should be explored in greater detail in the next phase of the study. In addition to an increase in knowledge, children believed that their math skills had improved.

Children's Reactions to the Programs and Characters

Figure 10
Content Knowledge by Grade

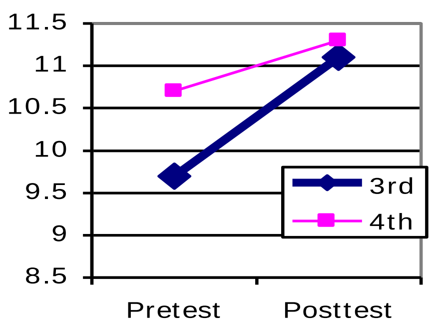
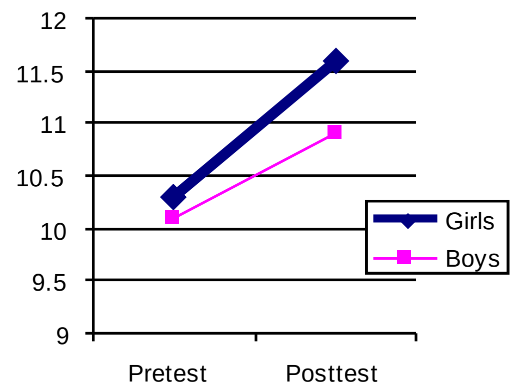
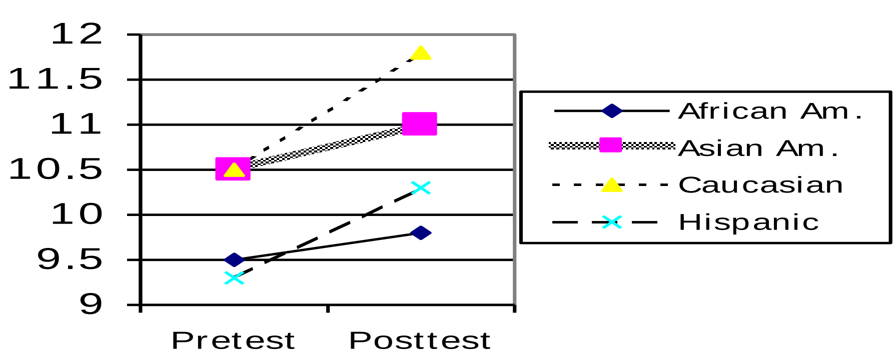


Figure 11
Content Knowledge by Gender



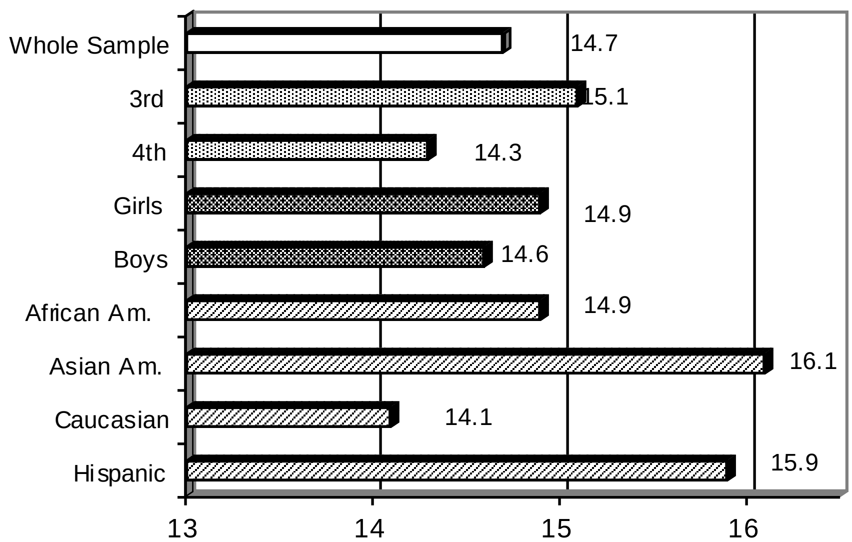
Children reacted positively to the Cyberchase program and the characters portrayed. After

Figure 12
Content Knowledge by Ethnicity



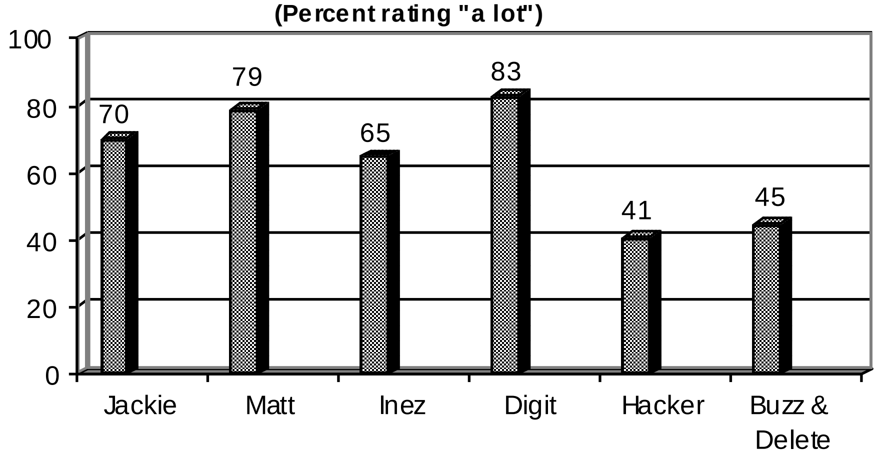
showing each program, we asked the children how much they enjoyed the episode. The cumulative findings are reported in Figure 13. The numerical values reflect a summary variable of the children's enjoyment of each of the five episodes. Girls reported greater enjoyment than boys. Third graders reported greater enjoyment than fourth graders. Asian-American and Hispanic children reported the most enjoyment by ethnic group. These phenomena should all be explored in phase two of the study.

Figure 13
Children's Enjoyment of Viewing Cyberchase



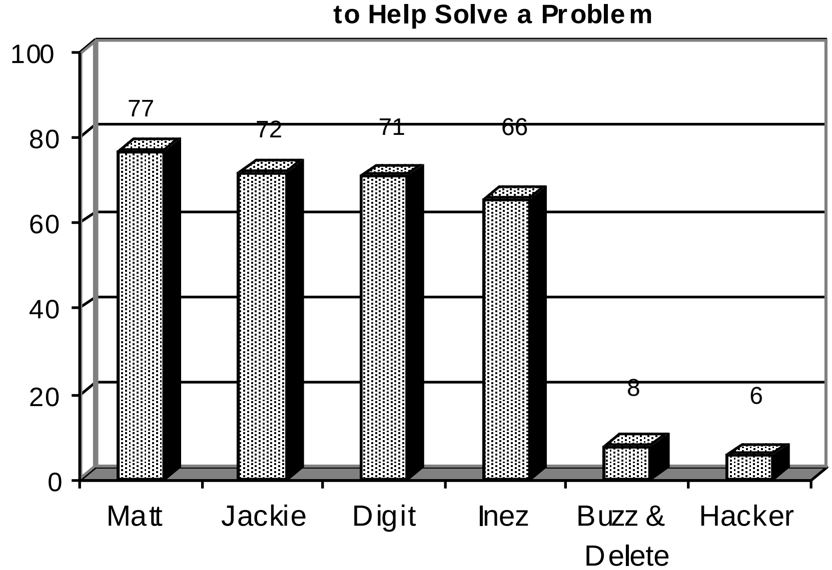
After viewing all the programs, the children reported how much they enjoyed each of the characters (Figure 14). Close to 70% of the sample reported liking each of the "good guy" characters "a lot", and nearly 50% reported liking the "bad guy" characters "a lot".

Figure 14
Children's Enjoyment of Each Character
(Percent rating "a lot")



We also asked the children to choose which of the characters they would like to help them solve a math problem. Most children chose the four "good guy" characters to help them (Figure 15). The children chose, in descending order, Matt, Jackie, Digit and Inez. When

Figure 15
Percentage Selecting Each Character to Help Solve a Problem



asked to provide a list of words describing each of the characters, the most common words were smart, nice, funny and cool (see Table 1.) The children in the study were quite consistent in their choices of words to describe the characters.

Table 1: Sample's Descriptions of Cyberchase Characters

Character	Most Common Descriptor (%)	2nd Descriptor (%)	3rd Descriptor (%)	4th Descriptor (%)	5th Descriptor (%)
Jackie	Smart 44	Nice 34	Funny 25	Cool 17	Friendly 12
Matt	Smart 46	Nice 30	Cool 30	Funny 27	Helpful 9
Inez	Smart 46	Nice 29	Funny 20	Cool 17	Helpful 8
Digit	Funny 52	Smart 25	Cool 22	Nice 22	Helpful 13
Hacker	Mean 51	Evil 21	Funny 12	Weird 11	Dumb 8
Buzz & Delete	Funny 34	Mean 25	Weird 20	Dumb 18	Stupid 11

"It's amazing how TV captures their attention." - teacher

"They loved [Cyberchase]. Some have visited the website. They can't wait for the program to begin in January." - teacher

"Cyberchase links education to [children's] own experience: watching cartoons." - teacher

Teachers' Reactions to Cyberchase and its Characters
Teachers were enthusiastic about the series, suggested having stronger math content to help justify its use in the classroom, and planned to use it to support their math teaching. In addition to the previous teacher quotes, the following are also representative of their reactions:

"I have found myself laughing - it is very engaging." - teacher

"I think that some students find math more fun and most of the class sees math more as a useful tool rather than a compartmentalized subject." - teacher

"I am not sure I would classify it as attitude, but it has opened students' eyes to all the area they use math in." - teacher

"[The children show] a greater interest in math [after watching Cyberchase]" - teacher

These materials are developed in greater detail in the next section "Technical Details", beginning on the following page.

TECHNICAL DETAILS

What is Cyberchase?

Cyberchase is billed as a "groundbreaking animated adventure series" produced by WNET (PBS Channel Thirteen (13)) in New York City). The program will be on-air and online, and "promises to engage children ages 8 to 11 in the excitement and challenge of math and logic". The multimedia series is to premiere during the winter of 2002. Cyberchase is a math series for television that uses dramatic adventure stories designed to inspire eight to eleven-year-old viewers to be interested in and have an appreciation for mathematics . The math series introduces them to important mathematical tools and problem solving strategies. The shows close with short, live-action segments that link the math topics to children's every day lives.

The program features three Earth kids (Jackie, Matt, and Inez). Their mission in cyberspace is to help Motherboard defeat the evil Hacker. They must use math and logic to survive their adventures in cyberspace. Each week the Earth kids embark on exciting new adventures, and encounter several new math challenges that are seamlessly integrated into the storyline. The characters model the process of problem solving in a clear, visual way, so viewers are encouraged to solve the problems along with them. Whether they're working alone or in a group, the kids still have to rely on their logic and thinking skills -- as opposed to magic -- to work out their math problems.

WNET expects to attract a broad audience with fast-paced, compelling storylines that incorporate humor and feature a cast of diverse characters. Strong and appealing ethnically diverse and both male and female heroes should draw in youngsters who may have felt intimidated by math in the past. WNET's goal in developing the program is to recast math as fun, familiar, and applicable to our everyday lives. There is a link to Cyberchase on the PBS kids home page at: http://pbskids.org/cyberchase/.

Introduction

ROCKMAN *ET AL* was asked to provide solid quantitative data for two phases of the pilot (pre release (this report), and winter 2002 on-air release).

- Volume I of this report is a stand-alone piece "Executive Summary".
- Volume II (which also includes Volume I at the beginning) is the detailed technical analysis that provides all the background for the findings in Volume I.
- Volume III is the codebook for the Cyberchase project.

Methodology

After reviewing the five rough-cut videos to be included as part of the treatments, ROCKMAN ***ET AL*** worked with the content experts at WNET to design research questions. The measurement instruments were designed to cover the major issues addressed by the research questions (outlined below).

Research Design

There were four research questions that correspond by number to the desired outcomes, as defined by WNET. The outcomes are outlined and defined in the following section. Each research question also addresses group differences (by gender, grade, and ethnicity).

Research Questions

Each of the four research questions was addressed through an examination of specific composite indices of questions that were administered in the Pretest and Posttests. The details of the construction of the composite indices are outlined in Appendix III. Treatment ("T_x") was exposure to five Cyberchase episodes.

1. Do children have more positive attitudes about doing math after T_x?
2. Do children have greater awareness about the scope of math after T_x?
3. Do children have greater self-confidence/interest in problem solving after T_x?
4. Do children have greater comprehension/understanding of content after T_x?

Research Hypotheses

To accompany the research questions, WNET asked ROCKMAN ***ET AL*** to create hypotheses. The hypotheses are outlined below.

1. Children have more positive attitudes about doing math after T_x.
2. Children have a greater awareness about the scope of math after T_x.
3. Children have greater self-confidence/interest in problem solving after T_x.
4. Children have greater comprehension/understanding of the content after T_x

Treatment & Timing

The definition of treatment ("T_x") is exposure to five selected episodes (shown in this order) of Cyberchase during a two-week period (October 12 to October 24, 2001):

1. Lost My Marbles (Navigation)
2. Snow Day to be Exact (Estimation)
3. Sensible Flats (Area)
4. Zeus on the Loose (Fractions)
5. Castleblanca (Data)

Outcomes

1. Attitudes about doing math. How children feel about math.
2. Perception of what math is about and awareness of the scope of math. How broadly children define what math encompasses.
3. Interest, skills, self-confidence in mathematical problem solving. How children feel about their own abilities to solve mathematical problems.
4. Content comprehension and acquisition of knowledge presented in the episodes. How much information the children understand from viewing Cyberchase.

Measures

Math content experts at WNET and ROCKMAN ***ET AL*** worked together to create a master list of questions that addressed each of the outcomes (attitude, awareness, problem solving, and content), in addition to questions that assessed baseline self-confidence in math skills. From this master list, seven child-directed instruments were created: Pretest, five Episode Specific Posttests (one to follow each of the five tapes), and an Aggregate Posttest (given five days after the final episode was shown). The measures are all included in the codebook (Volume III). As a result of the short time frame for the study implementation and data collection, the episode specific Posttests are not included in their entirety in this report. Feedback from teachers indicated that the Pretest and Posttest were too long and taxing for children of this age.

There were also seven teacher-directed instruments that paralleled the child-directed instruments. The teacher instruments were all open ended, and have scoring rubrics (see sections on each of the instruments). Specific quotations from the teachers about Cyberchase are also included in the sections addressing specific episodes. The data can be used to inform the second phase of the research project.

Variable Indices

The questions addressing each of the outcomes were lumped together into composite indices, by type and focus of question. The details of which variables were included in each index are provided in Appendix III. The sample size in each of the indices varies since they were all composite variables. For a subject to be counted, s/he had to have reported data in each of the components. In all other cases (where one child did not have a full complement of the composite variables), the summary variable was eliminated from the analysis. This provided a needed degree of security in comparing across data. Most of the variables were scored in reverse, so that a lower score corresponds to a more positive outcome.

General Note on Scoring

For the summary report (Volume I, only) many of the data scoring schemes were transformed, for ease of understanding, so that a higher score represented a better skill or more positive attitude. This volume (Volume II) on the technical details sticks to the raw data. The directions and ranges of possible scores are detailed in each of the sections on the instruments (Pretest, Posttest1, Posttest2, Posttest3, Posttest4, Posttest5, Posttest).

All of the instruments were scored, coded, entered, cleaned and analyzed by ROCKMAN ***ET AL.*** Each of the qualitative questions was scored by the same scorer, which eliminates the need for a measure of inter-rater reliability.

General Math Attitude

Math attitude questions were all scored on a scale from one (high) to five (low) so that a lower score indicated a more positive attitude towards math. Since there were statistically significant differences (see “Demographics” section) in current math grade by both grade level ($p=.01$) and ethnicity ($p=.00$), the variable of child self-rank math grade was excluded from these analyses. There were two composite variables measuring attitude: one that was a baseline, and one that was hoped would change as a result of the treatment. Appendix III details the construction of this index.

Math Awareness

The Pretest included sections where children were asked to list words that had to do with math, and how people use math everyday. There were additional sections asking children to identify items as math from a list that were math-related activities. These items were summed for a total score. These sums were combined with the open-ended section scores for one composite index. This variable is scored from low to high (higher score = broader awareness). There were nineteen (19) variables in this index (See Appendix III)

Problem Solving Self Confidence

This section consisted of asking children to rate how comfortable they felt about doing various math activities. The answers were scored on a scale from one (high) to five (low) so that a lower score indicated a more positive attitude towards math problem solving. Appendix III details the construction of this index.

Content Questions

The episodes each had a specific content theme. There were questions on the Pretest and the individual Posttests that address the same specific content (navigation, estimation, area, fractions, and data). These questions were each scored on a five-point scale (from 0 to 4). (See Appendix IV for additional comments on scoring).

Validity

Validity is defined as a measure of how well items or indices measure what they claim to measure. An examination of the intercorrelations between the summary variables on both the Pretest and the Posttest reveal that the instruments have good internal validity. The math experts who assembled the questions led to strong construct validity as well.

Reliability

Reliability is a measure of how likely you are to be able to repeat a study, and get the same results (also called "replicability"). Cronbach's Alpha (α) is a measure of how well individual responses to items in a composite index are correlated. Like a simple correlation, alpha can range from 0.0 (very low) to 1.0 (perfectly reliable). Alpha was calculated as a measure of reliability on each of the Pretest and Posttest composite variable indices (Table 2). The alpha results indicated that most of the indices were very strong, and all were acceptable.

Table 2
Chronbach's Alpha and Reliability Measure for Indices

Variable	Sample Size (n)	Cronbach's Alpha (α)
Pretest Baseline General Math Attitude	430	.45
Pretest General Math Attitude	435	.75
Posttest General Math Attitude	433	.79
Pretest Math Awareness	406	.61
Posttest Math Awareness	436	.65
Pretest Math Problem Solving Confidence	448	.89
Posttest Math Problem Solving Confidence	410	.79
Pretest Math Content	450	.69
Posttest Math Content	350	.50

Timing & Implementation

The tapes were shown over a two-week period, not more than one tape per day, with the corresponding Posttest given the same day. The last tape was shown by October 24, 2001. The Posttest was given on October 29, 2001**.** Demographic information on the sample was requested at the outset of the study so that some preliminary analyses could be started. A calendar of requested implementation was sent to teachers with the instructions, color-coded child-directed instruments, and each corresponding videotape, bundled together for ease of implementation (see Appendix II for the calendar).

Sample & Selection

Twenty (20) San Francisco Bay Area sites enrolled as participants in this pilot phase study. Most were from relatively underserved neighborhoods, with the sample equally split between 3rd and 4th grade, and in urban or suburban locations. Teachers were sent a confirmation letter along with the WNET introductory materials and poster on October 4, 2001. Most sites received the tapes and instruments on October 9 or 10, 2001. The teachers were provided with an incentive of a digital camera (Fine Pix 1300), which operates across platforms (for Mac- or pc-based users, including battery charger, and case). Twenty (20) additional sites expressed interest in the project, and have asked to be included in the second phase of the research (in addition to the twenty repeat teachers who participated in this phase).

Description

The study sample was comprised of twenty (n=20) classrooms in eleven (n=11) schools located in seven cities (n=7) in the San Francisco Bay Area. The sample consists of 465 children in third grade classrooms (n=12; 49%) and fourth grade (n=8; 51%); as outlined in Table 3.

Table 3
Summary Table of Sample Ethnicity by Gender and Grade

	Girls (n=238)		Boys (n=227)		Total (n=465)	
Third Grade	(n=118)	25%	(n=112)	24%	**(n=230)**	**49%**
African-American	6	1	7	2	13	3
Asian-American	12	3	21	5	33	7
Caucasian	70	15	65	14	135	29
Hispanic	29	6	18	4	47	10
Other	1	0	1	0	2	0
Fourth Grade	(n=120)	26%	(n=115)	25%	**(n=235)**	**51%**
African-American	8	2	15	3	23	5
Asian-American	33	7	28	6	61	13
Caucasian	60	13	50	11	110	24
Hispanic	16	3	22	5	38	8
Other	3	1	0	0	3	1
Total	**(n=238)**	**51%**	**(n=227)**	**49%**	**(n=465)**	**100%**
African-American	14	3	22	5	36	8
Asian-American	45	10	49	11	94	20
Caucasian	130	28	115	25	245	53
Hispanic	45	10	40	9	85	18
Other	4	1	1	0	5	1

Demographics

An initial demographic examination (by one-way ANOVA) revealed statistically significant differences by groups (ethnicity, gender, and grade) on several variables (current math grade, math class rank, and math rich environment (home rank)). Thus the following variables are excluded from this report and it is recommended that they not be included in the future.

Math Grade

At the elementary school level, grades are less consistently awarded than at later grades. There were statistically significant differences in current math grade by both grade level ($p=.01$) and ethnicity ($p=.00$).

Math Class Rank

Teachers' were not as confident in their abilities to rank students in their class this early in the year. Several teachers noted this, and others left the question blank. In any event, there were statistically significant differences in math class rank by ethnicity (p=.00).

Math Home Rank

Similar to the math class rank, teachers were less confident about their abilities to rank their students' home math environment. Statistically significant differences in math home rank were revealed by ethnicity (p=.00).

Data Collection

The teachers were delivered a well-organized box of materials (introduction, calendar, teacher checklist, child-directed instruments, teacher-directed instruments, tapes) and included specific instructions for implementation (to ensure consistency across sites). Each teacher was provided with a calendar for suggested implementation to ensure further consistency across the sites. Postage-paid envelopes were provided. Teachers were asked to complete the instruments and mail them back the day of completion, to facilitate data coding and entry (as described below).

Data Preparation

Each instrument asked for the child's first name and last initial. Each child (and each teacher) was assigned an identification number for confidentiality. A codebook (Volume III) was created to document all variables and their values. The child identification number was written on each of the instruments, and checked by another coder to assure accuracy. The open-ended data was scored, and noted on the actual instrument. Then the data was entered into coding sheets, and prepared for data entry into the computer system.

Codebook (Volume III)

A codebook was created to correspond to each of the instruments, and to include each of the possible responses for both the closed- and open-ended questions. A codebook facilitates accuracy in data coding, and data entry. For confidentiality, the codebook does not include the pages that detail the sample children, teacher, schools, or cities.

Statistical Software for Analysis

SPSS (Statistical Package for Social Sciences) was used to store and analyze the data. A separate SPSS file (each including child identification number as the unique variable) was created for each instrument, and for the demographic information. One final composite data file was created to compare Pretest and Posttest findings, including demographic information.

Quantitative Data

The nominal, ordinal, and scaled data were coded as outlined in the codebook (Volume III).

Qualitative Data

The open-ended questions were scored according to specific scoring rubrics, as outlined in the codebook (Volume III). All the answers were reviewed before the scoring rubrics were created, reviewed, and the data was scored. For consistency (and to eliminate any concerns about inter-rater reliability), the same scorer coded each of the content questions across all sample children. In the event that the same question was repeated in the Pretest and the Posttest (to measure change across treatment) the same scorer also coded both versions of the question.

Pretest

The Pretest included questions that addressed general math attitude, awareness, attitude towards math problem solving, and five content questions that addressed the topics in the five episodes of Cyberchase. The same content questions were repeated in the five episode specific Posttests.

Summary Report of Pretest Composite Variable Indices

Appendix III details the construction and components of these variable indices. In Table 4 a "?" indicates that there was not a possible maximum upper range. Since the variable indices were not created with the same number of variable components, the possible, and thus actual, ranges of scores for each variable index is different.

Table 4
Summary of Pretest Composite Variable Indices

Variable Name	Sample Size (n)	Scoring Direction	Number of Variables in Index	Possible Range of Scores	Actual Range of Scores	Mean (s.d.)
Child Pretest Baseline General Math Attitude	430	Low score → more positive attitude	8	8 - 45	9 – 45	20.2 (5.2)
Child Pretest General Math Attitude	435	Low score → more positive attitude	11	11 - 55	11 - 46	21.5 (6.7)
Child Pretest Math Awareness	406	High score → broader awareness	21	0 - ?	6 - 54	25.8 (8.7)
Child Pretest Math Problem Solving Confidence	448	Low score → more self-confidence	12	12 - ?	12 - 108	23.0 (10.7)
Child Pretest Math Content	450	High score → better content grasp	5	0 - 20	0 – 18	10.2 (3.0)

Interpretation

The sample size in the Pretest varies by variable since they are all composite variables. For a subject to be counted, s/he had to have reported data in each of the components.. This provides a needed degree of security in comparing across data. Most of the variables are scored in reverse, so that a lower score corresponds to a more positive outcome. Two of the variables are scored from low to high. Please refer to Table 4 for details.

Table 5 outlines the Pretest composite variables (see Appendix III for details on the construction and components of these indices). The data is presented for the entire sample (“whole sample”, as well as by grade (“third” and “fourth”), gender (“girls” and “boys”), and ethnicity (“African-American”, “Asian-American”, “Caucasian” and “Hispanic”) of the sample children. Since the sample is relatively small it was not feasible to review the data in a three-layer-cross-tabulation format: Grade x Gender x Ethnicity, without losing power as a result of small cell sizes. In general, and for phase two of the study, it would make sense to strive for a balanced sample, in which there are no group differences in the major composite variables. Table 5 (on the following page) details the variable indices by grade, gender, and ethnicity. Any statistically significant difference by group is indicated in **bold**.

Table 5
Summary of Pretest Composite Variable Indices by Grade, Gender and Ethnicity

Variable	Group/ Subgroup	Sample Size (n)	Mean (s.d.)	Group Differences
Child Pretest Baseline General Math Attitude	Whole Sample	430	20.2 (5.2)	
	Grade 3			
	Grade 4	214	19.6 (5.5)	**p = .02 ****
		215	20.8 (4.7)	(3rd Graders have a more positive baseline attitude)
	Girls	222	20.4 (5.9)	n.s.
	Boys	207	20.0 (4.3)	
	African-American	33	19.5 (4.5)	**p = .008 ***** (Hispanic children have a more positive baseline attitude towards math on the Pretest)
	Asian-American	91	20.1 (4.6)	
	Caucasian	225	20.6 (5.5)	
	Hispanic	73	18.9 (4.3)	
Child Pretest Math Attitude	Whole Sample	435	21.5 (6.7)	
	Grade 3	219	21.0 (6.2)	n.s.
	Grade 4	215	21.9 (7.2)	
	Girls	222	21.7 (6.8)	n.s.
	Boys	212	21.3 (6.6)	
	African-American	35	19.9 (6.9)	n.s.
	Asian-American	90	21.7 (7.5)	
	Caucasian	227	21.7 (6.5)	
	Hispanic	73	21.3 (6.7)	

* $p \leq .05$ ** $p \leq .01$ *** $p \leq .001$

Table 5 (continued)
Summary of Pretest Composite Variable Indices by Grade, Gender and Ethnicity

Variable	**Group/ Subgroup**	**Sample Size (n)**	**Mean (s.d.)**	**Group Differences**
Child Pretest Math Awareness	Whole Sample	406	25.8 (8.7)	
	Grade 3	199	24.7 (8.2)	**p = .02 **** (4th Graders have a broader awareness of the scope of math on the Pretest)
	Grade 4	206	26.7 (8.8)	
	Girls	208	26.3 (8.4)	n.s.
	Boys	197	25.0 (8.7)	
	African-American	31	25.2 (8.7)	**p = .001 ***** (Hispanic children have a broader awareness of the scope of math on the Pretest)
	Asian-American	86	25.9 (9.0)	
	Caucasian	209	27.0 (7.9)	
	Hispanic	70	22.0 (8.9)	
Child Pretest Math Problem Solving Confidence	Whole Sample	448	23.0 (10.7)	
	Grade 3	222	23.8 (13.4)	n.s.
	Grade 4	225	22.3 (7.2)	
	Girls	230	23.2 (10.5)	n.s.
	Boys	217	22.9 (11.0)	
	African-American	35	27.5 (22.5)	n.s.
	Asian-American	92	22.2 (7.2)	
	Caucasian	233	22.3 (5.9)	
	Hispanic	78	24.8 (16.0)	

* $p \leq .05$ ** $p \leq .01$ *** $p \leq .001$

Table 5 (continued)
Summary of Pretest Composite Variable Indices by Grade, Gender and Ethnicity

Variable	Group/ Subgroup	Sample Size (n)	Mean (s.d.)	Group Differences
Child Pretest Math Content	Whole Sample	450	10.2 (3.0)	
	Grade 3	231	9.7 (3.0)	**p = .000 *** ** (4th graders scored higher on the Pretest content questions)
	Grade 4	217	10.7 (2.9)	
	Girls	228	10.3 (2.9)	n.s.
	Boys	220	10.1 (3.0)	
	African-American	34	9.5 (2.8)	**p = .008 **** (Asian-American and Caucasian children scored highest on the Pretest content questions)
	Asian-American	87	10.5 (3.3)	
	Caucasian	238	10.5 (2.6)	
	Hispanic	80	9.3 (3.5)	

* $p \leq .05$ ** $p \leq .01$ *** $p \leq .001$

Interpretation

The table reviews the group differences for each of the five Pretest composite variables. In the Child Pretest Baseline General Math Attitude (measured only in the Pretest, and reflective of home and school "math-rich" environments), third graders had a more positive baseline attitude towards math than fourth graders. There were no differences between girls and boys in the sample. There were some ethnic differences in the Child Pretest Baseline Math Attitude: Hispanic children had the most positive general attitude towards math.

There were no group differences in Child Pretest Math Attitude variable.

In the Child Pretest Math Awareness of the scope of mathematics, there were some group differences. Fourth graders had a broader awareness of the scope of math than third graders. There were no differences between girls and boys in the sample. There were some ethnic differences in the Child Pretest Math Awareness variable: Hispanic children had the broadest awareness of the scope of math.

There were no group differences in the Child Pretest Math Problem Solving Confidence variable.

Table 6 details the correlations ("r") among the variable indices for the study sample. A correlation measures the degree of relationship between one variable and another, across the sample. Correlation does not indicate any degree of causality, simply the relationship. Correlation can range in value from 0.0 to 1.0. and can be either negative (as one variable increases, the other decreases) or positive (as one variable increase in value, the other variable also increases in value). Statistically significant correlations are indicated in **bold**. The sample size upon which each correlation value ("r") is based is noted in parentheses (n) below the correlation. By definition, any variable correlated with itself is a perfect correlation (1.0). Any negative correlations are indicated by the r value being presented in parentheses (standard accounting notation).

Table 6
Intercorrelations between Pretest Composite Variable Indices[1]

	Child Pretest Baseline General Math Attitude[2] r (n)	Child Pretest Math Attitude r (n)	Child Pretest Math Awareness r (n)	Child Pretest Math Problem Solving Confidence r (n)	Child Pretest Math Content r (n)
Child Pretest Baseline General Math Attitude	1.00 (430)				
Child Pretest Math Attitude	**.43** *** (423)	1.00 (435)			
Child Pretest Math Awareness	(.02) (388)	**(.16)** *** (393)	1.00 (406)		
Child Pretest Math Problem Solving Confidence	**.25** *** (428)	**.45** *** (433)	**(.12)** * (404)	1.00 (448)	
Child Pretest Math Content	.07 (411)	.01 (416)	.02 (388)	**(.14)**** (429)	1.00 (450)

* $p \leq .05$ ** $p \leq .01$ *** $p \leq .001$

[1] See Appendix III for details on the construction and components of these variable indices
[2] This variable is not included in the Posttest measures

Interpretation

The matrix above correlates the Pretest composite variables with each other. As expected, each variable, when correlated with itself, generates a perfect score of 1.0. Keeping in mind that some of the variables are scored in opposite directions, the following statements hold true:

- Child Pretest Baseline General Math Attitude is strongly correlated with Child Pretest Math Attitude. This makes sense inherently.
- Child Pretest Baseline General Math Attitude is strongly correlated with Child Pretest Math Problem Solving Confidence. This also makes sense.
- Child Pretest Math Attitude is strongly correlated with Child Pretest Math Awareness, which also makes sense.
- Child Pretest Math Attitude is strongly correlated with Child Pretest Math Problem Solving Confidence, which also makes sense.
- Child Pretest Math Awareness is strongly correlated with Child Pretest Math Problem Solving Confidence, which also makes sense.

Teacher Comments on Pretest

The teacher Pretest asked open-ended questions about their general math and learning philosophy. It was hoped that there would be group differences (grade and/or gender) in the Pretest philosophies, by which to examine the findings in general. There were no differences between the teachers on any of the items on any of the measures. The open-ended questions were scored with a rubric, which was created after reading all the responses. The points are hierarchical to a degree, with a lower score indicating a more teacher-directed classroom, and a higher score indicating a more child-directed classroom.

General Philosophy: Four common, but not mutually exclusive, philosophies of instruction are: addressing different learning styles (visual, auditory, tactile), modeling, having teacher-directed instruction, and doing hands-on activities. Most of the responses included a combination of the aforementioned philosophies. The underlying theme: teachers said they needed to utilize a variety of methods to meet the individual needs of each student.

Scoring rubric for Teacher Pretest: General Philosophy

Question	Points	Scoring Rubric
#1 p. 1	1	A variety of ways-no specifics given
	2	Concrete experience: i.e. auditory, visually, tactile
	3	Hands on experience: discovery, repetition, manipulatives, drills, and practice
	4	Social interaction & Modeling: emotional and social experiences
	5	Sequential learning: a combination of teaching styles, showing relevancy, build on learning

Supporting Quotes From Teachers on Pretest re: General Philosophy:

- Children learn in a variety of ways: hands on, audio, visual, reading, writing, moving, etc.
- I believe that students learn in different ways and at their own pace.
- Children learn in a variety of ways. They need real experiences, practice, and hands on. They need to learn from each other at times and discover things.

Math philosophy: Most teacher responses indicated students had different learning styles (visual, auditory, and tactile). They also noted the importance of hands-on activities in order for children to understand math. It is worth noting that teachers' math philosophies did not differ from their general instructional philosophy.

Scoring rubric for Teacher Pretest: Math Philosophy

Question	Points	Scoring Rubric
#2 p. 1	1	A variety of ways-no specifics given
	2	Concrete experience: i.e. auditory, visually, tactile
	3	Hands on experience: discovery, repetition, manipulatives, drills, and practice
	4	Social interaction & Modeling: emotional and social experiences
	5	Sequential learning: a combination of teaching styles, showing relevancy, build on learning

Supporting Quotes From Teachers on Pretest re: Math Philosophy:

- Different children learn math in different ways.
- I think it's necessary to use a variety of tools – they need to experience/learn concepts in different ways (e.g. video, auditory, experience, etc.)
- I think students need to see how math can be part of their lives and how it can help them learn it.

Math instruction: Using a variety of approaches to teaching math was the only common theme among teachers' philosophies. Participants reported using many tools: Excel program, computer games, manipulatives, paper & pencil. They used different learning methods such as memorization and critical thinking. The participants also reported different groupings: small groups, large groups, individual students, peer-to-peer tutoring.

Scoring rubric for Teacher Pretest: Math Instruction

Question	Points	Scoring Rubric
#3 p. 1	1	A variety of ways-no specifics given
	2	Concrete experience: i.e. auditory, visually, tactile
	3	Hands on experience: discovery, repetition, manipulatives, drills, and practice
	4	Social interaction & Modeling: emotional and social experiences
	5	Sequential learning: a combination of teaching styles, showing relevancy, build on learning

Supporting Quotes From Teachers on Pretest re: Math Instruction:

- I run the gamut from straight skills to using manipulative. Every kid learns differently – you need a smorgasbord of techniques.
- My push is for students to understand what they're doing – not just perform on cue. Students are required to elaborate on how they solved a problem, many diverse approaches are valued, and mathematical reasoning is expected.
- I do a combination of hands on lessons using manipulatives, math games, teaching good strategies, and how we write math.

Navigation: Teachers reported teaching the use of maps in steps. Most began with explaining key map elements such as legend and symbols. Then, students engaged in hands-on activities such as drawing a map or partaking in a treasure hunt. Many reported tying the map topic with Social Studies lessons.

Scoring rubric for Teacher Pretest: Navigation Instruction

Question	Points	Scoring Rubric
#4 p. 2	1	Teacher directed: teacher goes over material in structured way
	2	Student directed: teacher facilitates activities so students discover concepts themselves
	3	Holistic direction: combination of above two philosophies
	4	Classroom centered: teacher gives the whole class same assignment
	5	Individually centered: teacher allow different activities for different students

Supporting Quotes From Teachers on Pretest re: Navigation Instruction

- I give them a grid map of the classroom, show them using overhead how to use it. Then, they go on a treasure hunt using their maps. A follow up is they get to hide something and then make their own map.
- I use a program called Map Champ. I teach them about direction, continents, cultures, map keys, and more. They work independently, in groups and as a whole class.
- Coordinate practice in math, reading map keys, making their own maps – it's also part of our social studies text and curriculum.

Estimation: unlike other concepts included in this survey, participants mentioned both conceptual and hands-on instructional strategies. Most begin instruction with explaining the concept of estimates, including the rules for estimating. Then, students participated in activities: estimating different objects such as guessing the number of jellybeans in a jar, finding real life examples, and doing paper and pencil exercises.

Scoring rubric for Teacher Pretest: Estimation Instruction

Question	Points	Scoring Rubric
#5 p. 2	1	A variety of ways-no specifics given
	2	Concrete experience: i.e. auditory, visually, tactile
	3	Hands on experience: discovery, repetition, manipulatives, drills, and practice
	4	Social interaction and modeling: emotional and social experiences
	5	Sequential learning: a combination of teaching styles, showing relevancy, build on learning

Supporting Quotes From Teachers on Pretest re: Estimation Instruction

- They need to understand the concept of rounding first, and the rule. They also need an understanding that estimation is not an exact number, but a number that is close enough.
- Rounding is an important element in estimates. I often use money as a basis because they're familiar with that already.
- We do an estimating jar activity each week with different objects. We also estimate the answers to problems before solving them.

Area: Participating teachers relied primarily on hands-on activities to teach children to calculate area. Graphing paper was the most popular tool. However, teachers said they used manipulatives, geoboards, and Marilyn Burns units. Others said they had students measure objects in the classroom, again with the emphasis on real-life relevancy.

Scoring rubric for Teacher Pretest: Area Instruction

Question	Points	Scoring Rubric
#6 p. 2	1	A variety of ways-no specifics given
	2	Concrete experience: i.e. auditory, visually, tactile
	3	Hands on experience: discovery, repetition, manipulatives, drills, and practice
	4	Social interaction and modeling: emotional and social experiences
	5	Sequential learning: a combination of teaching styles, showing relevancy, build on learning

Supporting Quotes From Teachers on Pretest re: Area Instruction

- I teach them how to calculate area on paper as well as by measuring objects in the classroom as well as at home.
- I bring out cubes and will build a 3D object. Then, we talk about l x w, and how it finds the area of an object.
- I start with the Marilyn Burns unit on area, and the fence problem. We act it out then do it on paper. Then to traditional problems.

Fractions: Teachers reported high usage of hands-on activities to teach children about fractions. Important activities include: food games, manipulatives, drawing, fraction kits, and fraction strips. Many teachers related fraction lessons to “real-life” scenarios.

Scoring rubric for Teacher Pretest: Fraction Instruction

Question	Points	Scoring Rubric
#7 p. 2	1	A variety of ways-no specifics given
	2	Concrete experience: i.e. auditory, visually, tactile
	3	Hands on experience: discovery, repetition, manipulatives, drills, and practice
	4	Social interaction and modeling: emotional and social experiences
	5	Sequential learning: a combination of teaching styles, showing relevancy, build on learning

Supporting Quotes From Teachers on Pretest re: Fraction Instruction

- Using fraction tiles, fraction games, fraction stories.
- Children use manipulatives to gain hands on experience. We also discuss why an object would need to split and talk about real life examples.
- I teach fractions by relating it to food/candy to being with, but quickly move to creating construction paper models (both rectangle and circle) and on to games to show equivalency.

Survey: Most participants said they used enactment to teach their students how to use a survey. Their students wrote directions, polled peers, or filled out questionnaires. Teacher said they used these data to teach computations and to create graphs for classes.

Scoring rubric for Teacher Pretest: Survey Instruction

Question	Points	Scoring Rubric
#8 p. 3	1	Teacher directed: teacher goes over survey in structured way
	2	Student directed: teacher facilitates activities so students discover survey concepts
	3	Holistic direction: combination of above two philosophies
	4	Classroom centered: teacher allow different activities for different students
	5	Individually centered: teacher gives the whole class same assignment

Supporting Quotes From Teachers on Pretest re: Survey Instruction

- Each year, I start with graphing, so each child writes their own survey. We also do surveys as a class first. By fourth grade, most students have a good understanding.
- We collect information from fellow students and then make graphs using the data.
- The first time, we graph as a class. When students understand how to graph data, they work in small groups. Lastly, students work individually to demonstrate understanding.

Posttest One: Navigation

Means and standard deviations are rounded off to the closest decimal point. Table 7 details the individual variables from Posttest1 for the entire sample.

Table 7
Summary Report of Navigation Posttest Variables

Variable	**Sample Size (n)**	**Scoring Direction**	**Possible Range of Scores**	**Actual Range of Scores**	**Mean (s.d.)**
How much did you know about using a map before watching Cyberchase?	405	Low score → better knowledge	1 – 5	1 – 5	2.0 (1.1)
How well did you think you could use a map before using Cyberchase?	403	Low score → better knowledge	1 – 5	1 – 5	1.9 (0.9)
How much did you like this Cyberchase show?	398	Low score → liked better	1 – 5	1 – 5	1.3 (0.7)
What age group do you think that using a map is appropriate for?	404	Low score → younger age	1 – 5	1 – 5	2.9 (0.9)
How much did you learn about using a map after watching Cyberchase?	403	Low score → learned more	1 – 5	1 – 5	1.7 (1.0)

Interpretation

An initial examination (by one-way ANOVA) of the Posttest1 variables revealed statistically significant differences by groups (Table 8). This table details the variables from Posttest1 by grade, gender, and ethnicity. Any statistically significant difference by group is indicated in **bold**.

Table 8
Group Differences in Posttest1 Variables: Navigation

Variable	**Sample Size (n)**	**Grade**	**Gender**	**Ethnicity**
How much did you know about using a map before watching Cyberchase?	405	n.s.	**p = .000 ***** (Boys know more about navigation)	n.s.
How well did you think you could use a map before using Cyberchase?	403	n.s.	n.s.	n.s.
How much did you like this Cyberchase show?	398	**p = .006 **** (3^{rd} Graders liked this episode more)	n.s.	n.s.
What age group do you think that using a map is appropriate for?	404	n.s.	n.s	n.s.
How much did you learn about using a map after watching Cyberchase?	403	**p = .005 **** (3^{rd} Graders learned more about navigation)	n.s.	**p = .002 **** (Hispanic children learned more about navigation)

* $p \leq .05$ ** $p \leq .01$ *** $p \leq .001$

Teacher Comments on Posttest1

Children's reaction: Teachers said their students were largely just as enthusiastic about the program on maps as with previous episodes.

Scoring Rubric on Teachers' Perceptions of Children's Reactions: Navigation Posttest

Question	Points	Scoring Rubric
#1 p. 1	1	Generally or as enthusiastic about the program as compared to other Cyberchase videos
	2	Less enthusiastic about the program as compared to other Cyberchase videos.
	3	More enthusiastic about the program as compared to other Cyberchase videos.

Supporting Quotes From Teachers re: Children's Reactions on Navigation Posttest

- Most enjoyed it. They watched quietly – that's always a good response.
- Loved it! "Ah…that's all? When do we get to watch the next one?"
- They enjoyed the jokes. The map skills were clear and concise. Examples were provided which should lead to a majority of correct answers on page 3.

Constructive Quotes From Teachers re: Children's Reactions on Navigation Posttest

- They seemed to really enjoy the movie, however, several kids asked me what math they learned.
- They were fully engaged and fascinated by the navigation show. Some of them get the idea of coordinates and others didn't but it was definitely a good introduction.

Teacher's reaction: Most teachers reported enjoying the area video. Others like it but offered suggestions.

Scoring Rubric on Teachers' Reactions: Navigation Posttest

Question	Points	Scoring Rubric
#2 p. 1	1	Overall approval of the program
	2	Approved of the program but offered suggestions or rooms for improvement
	3	Did not approve of the program or a lot of criticisms

Supporting Quotes From Teachers on Navigation Posttest

- I also enjoyed the video. It had a nice balance of education and entertainment values. I especially like the real life application part that came at the end. It reminded me a lot of Reading Rainbow.
- I enjoyed the presentation of the skills. I also appreciate those skills being taught within the context of the story.

Constructive Quotes Teachers on Navigation Posttest

- It was decent, but it would be much more useful to show the character using the map skills more times to make the point of the lesson more obvious.
- The beginning was hard to understand until you get used to Hacker's voice. After that, I loved it.

Posttest Two: Estimation

Means and standard deviations are rounded off to the one decimal place.

Table 9
Summary Report of Posttest2 Variables: Estimation

Variable Name	**Sample Size (n)**	**Scoring Direction**	**Possible Range of Scores**	**Actual Range of Scores**	**Mean (s.d.)**
How much did you know about making estimates before watching Cyberchase?	412	Low score → better knowledge	1 – 5	1 – 5	1.8 (0.9)
How well did you think you could make estimates before watching Cyberchase?	412	Low score → better knowledge	1 – 5	1 – 5	1.9 (0.9)
How much did you like this Cyberchase show?	411	Low score → liked better	1 – 5	1 – 5	1.3 (0.7)
What age group do you think that making estimates is appropriate for?	412	Low score → younger age	1 – 5	1 – 5	2.7 (0.8)
How much did you learn about making estimates after watching Cyberchase?	411	Low score → learned more	1 – 5	1 – 5	1.7 (1.0)

An initial examination (by one-way ANOVA) of the Posttest2 variables revealed statistically significant differences by groups as detailed in Table 10:

Table 10
Group Differences in Posttest2 Variables: Estimation

Variable Name	Sample Size (n)	Grade	Gender	Ethnicity
How much did you know about making estimates before watching Cyberchase?	412	**p = .005 **** (4th Graders know more about making estimates)	**p = .005 **** (Boys know more about making estimates)	**p = .031 *** (Asian-Americans know more about making estimates)
How well did you think you could make estimates before watching Cyberchase?	412	n.s.	n.s.	n.s.
How much did you like this Cyberchase show?	411	n.s.	n.s.	**p = .031 *** (Hispanics liked this episode more than other ethnic groups)
What age group do you think that making estimates is appropriate for?	412	n.s.	n.s	n.s.
How much did you learn about making estimates after watching Cyberchase?	411	n.s.	n.s	n.s.

* $p \leq .05$ ** $p \leq .01$ *** $p \leq .001$

Interpretation

In the Posttest2, there were no significant group differences in three variables: "How well did you think you could make an estimate…?", "What age group do you think …?", and "How much did you learn about making estimates …?". When asked "How much did you know about making an estimate …?" there were gender, grade, and ethnic differences. When asked "How much did you like this Cyberchase show?" there were grade differences.

Teacher Comments on Posttest2

Children's reaction: Teachers said their students were largely just as enthusiastic about the estimation video as with previous videos.

Scoring Rubric on Teachers' Perceptions of Children's Reactions: Estimation Posttest

Question	Points	Scoring Rubric
#1 p. 1	1	Generally or as enthusiastic about the program as compared to other Cyberchase videos
	2	Less enthusiastic about the program as compared to other Cyberchase videos.
	3	More enthusiastic about the program as compared to other Cyberchase videos.

Supporting Quotes From Teachers on Children's Reactions re: Estimation Posttest

- I noticed how excited the kids got when it was time to watch the video. I also noticed them thinking out loud and saying the correct answer to the estimation problems presented in the video.
- Although one student said that his favorite part was estimation, I believe that they weren't as interested in estimation as much as map skills.
- The children intently watched the show. Some of the humor went WAY over their heads. The kids laughed and reacted positively to the video.

Teacher's Reactions: Scoring Rubric on Teachers' Reactions: Estimation Posttest

Question	Points	Scoring Rubric
#2 p. 1	1	Overall approval of the program
	2	Approved of the program but offered suggestions or rooms for improvement
	3	Did not approve of the program or a lot of criticisms

Supporting Quotes From Teachers on Estimation Posttest

- Estimation can be a challenge to teach. I liked how the video portrayed it to everyday life scenarios.
- I liked how the video focused on the skill and repeated it several ways. This is a hard concept for children, so it was good to repeat it over.
- I liked the way estimation was defined in the movie. I also like the way they used items to "measure" (estimate). I liked how "estimate" was differentiated from "wild guess."

Constructive Quotes From Teachers on Estimation Posttest

- Another good set of math skills, but the explanations could have been more thorough.
- I was happier with this lesson because more math was introduced than in last video. My practice is that in 30 minutes, one should experience a lot of math. There are more areas when the characters could quickly mention their steps.
- I thought it did a better job than video #1 of incorporating many examples of estimation but it seemed that fewer of my students "get it" according to the post test (but it is a much harder concept to grasp than coordinates).

Posttest Three: Area

An initial examination (by one-way ANOVA) of the Posttest3 variables revealed statistically significant differences by groups as detailed in Table 11:

Table 11
Summary Report of Posttest3 Variables: Area

Variable Name	Sample Size (n)	Scoring Direction	Possible Range of Scores	Actual Range of Scores	Mean (s.d.)
How much did you know about figuring out an area before watching Cyberchase?	417	Low score → better knowledge	1 – 5	1 – 5	2.0 (1.1)
How well did you think you could figure out an area before watching Cyberchase?	417	Low score → better knowledge	1 – 5	1 – 5	2.0 (1.0)
How much did you like this Cyberchase show?	414	Low score → liked better	1 – 5	1 – 5	1.4 (0.8)
What age group do you think that figuring out an are is appropriate for?	413	Low score → younger age	1 – 5	1 – 5	2.7 (0.8)
How much did you learn about figuring out an area after watching Cyberchase?	412	Low score → learned more	1 – 5	1 – 5	1.8 (1.1)

An initial examination (by one-way ANOVA) of the Posttest3 variables revealed statistically significant differences by groups as detailed in Table 12:

Table 12
Group Differences in Posttest3 Variables: Area

Variable Name	Sample Size (n)	Grade	Gender	Ethnicity
How much did you know about figuring out an area before watching this Cyberchase show?	417	**p = .000** *** (4th Graders know more about figuring out an area)	**p = .002** ** (Boys know more about figuring out an area)	n.s.
How well could you figure out an area before watching this Cyberchase show?	417	**p = .000** *** (4th Graders can figure out an area better)	**p =.039 *** (Boys can figure out an area better)	**p =.037 *** (African-Americans can figure out an area better)
How much did you like this Cyberchase show?	414	n.s.	n.s	**p =.013 *** (Caucasian children like this show more)
What age group do you think that figuring out an area is appropriate for?	413	n.s.	n.s	n.s.
How much did you learn abou figuring out an area after watching Cyberchase?	411	n.s.	n.s	n.s.

* $p \leq .05$ ** $p \leq .01$ *** $p \leq .001$

Teacher Comments on Posttest3

Children's reaction: Teachers said their students were largely just as enthusiastic about the area video as with previous video. However, a small contingent reported varying levels of enthusiasm. Some responses indicated students were less enthusiastic, citing the lack of novelty. A smaller number of responses indicated students were more enthusiastic about the show, observing students had developed a relationship or connection with the characters.

Scoring Rubric on Teachers' Perceptions of Children's Reactions: Area Posttest

Question	Points	Scoring Rubric
#1 p. 1	1	Generally or as enthusiastic about the program as compared to other Cyberchase videos
	2	Less enthusiastic about the program as compared to other Cyberchase videos.
	3	More enthusiastic about the program as compared to other Cyberchase videos.

Supporting Quotes From Teachers on Children's Reactions re: Area Posttest

- They said, "This is the funniest and the easiest one." They really enjoy the characters and listen intently so that they can do well on the follow up Posttests.
- My class was again very enthusiastic about the show. They enjoy the fast paced action and the humor. One student stated that they real life portion at the end always helps her to understand the concept better.
- They were involved and participatory with the movie. They now know the characters and eager for each adventure. Today there were oohs and ahhs.

Constructive Quotes Supporting From Teachers on Children's Reactions re: Area Posttest

- They were quite engrossed for the first 15 minutes or so – then I began to notice them stretching and getting a bit antsy. Overall, I think they liked it.
- I seemed to have more kids ask how to do the problem on the last page.
- After 10 minutes, one of the children asked me what this tape was about, but other than that, they were focused.

Teacher's reaction: Most teachers reported enjoying the area video. Others like it but offered suggestions. Another did not enjoy it and said s/he would not use the area video.

Scoring Rubric on Teachers' Reactions: Area Posttest

Question	Points	Scoring Rubric
#2 p. 1	1	Overall approval of the program
	2	Approved of the program but offered suggestions or rooms for improvement
	3	Did not approve of the program or offered great criticisms

Supporting Quotes From Teachers on Area Posttest

- I thought they did a good job putting a lot of examples in the video. The real life application at the end of the video and the cutting of the grid were good examples.
- I liked the connection to moving west, and the different shapes being near the same size. So far, this is my favorite.
- I liked that the video showed the relationship between counting each square or using multiplication to find the area.

Constructive Quotes From Teachers on Area Posttest

- I enjoyed the video, however, I don't think the message was conveyed as well as the other videos. It is still a great video, but I think it would be more effective to use it as an aid after some pre-teaching.
- I found this a little bit more clear than the "estimation." It was interesting and the math was more evident.
- Not enough math to spend 30 minutes on. I'm not sure if steps to "think-out" area were clear. Perhaps numbering and printing steps would help explain strategies. Plus, when kids see a sentence (a difference in the action), they might know something like a direction is coming up.

Posttest Four: Fractions

An initial examination (by one-way ANOVA) of the Posttest4 variables revealed statistically significant differences by groups as detailed in Table 13.

Table 13
Summary Report of Posttest4 Variables: Fractions

Variable Name	**Sample Size (n)**	**Scoring Direction**	**Possible Range of Scores**	**Actual Range of Scores**	**Mean (s.d.)**
How much did you know about fractions before watching this Cyberchase show?	419	Low score → better knowledge	1 – 5	1 – 5	1.9 (1.0)
How well did you think you could do fractions before watching this Cyberchase show?	419	Low score → better knowledge	1 – 5	1 – 5	1.9 (0.9)
How much did you like this Cyberchase show?	419	Low score → liked better	1 – 5	1 – 5	1.4 (0.7)
What age group do you think doing fractions is appropriate for?	418	Low score → younger age	1 – 5	1 – 5	2.7 (0.7)
How much did you learn about doing fractions after watching this Cyberchase show?	418	Low score → learned more	1 – 5	1 – 5	1.8 (1.1)

An initial examination (by one-way ANOVA) of the Posttest4 variables revealed statistically significant differences by groups as detailed in Table 14:

Table 14
Group Differences in Posttest4 Variables: Fractions

Variable Name	Sample Size (n)	Grade	Gender	Ethnicity
How much did you know about fractions before watching this Cyberchase show?	419	n.s.	n.s.	n.s.
How well did you could do fractions before watching this Cyberchase show?	419	n.s.	n.s.	n.s.
How much did you like this Cyberchase show about fractions?	419	n.s.	n.s	n.s.
What age group do you think that doing fractions is appropriate for?	418	n.s.	n.s	n.s.
How much did you learn abou fractions after watching Cyberchase?	418	**p = .005 **** (3rd Graders learned more about fractions)	n.s	n.s.

* $p \leq .05$ ** $p \leq .01$ *** $p \leq .001$

Teacher Comments on Posttest4

Children's reaction: Teachers said their students were largely just as enthusiastic about the fractions video as with previous videos.

Scoring Rubric on Teachers' Perceptions of Children's Reactions: Fraction Posttest

Question	Points	Scoring Rubric
#1 p. 1	1	Generally or as enthusiastic about the program as compared to other Cyberchase videos
	2	Less enthusiastic about the program as compared to other Cyberchase videos.
	3	More enthusiastic about the program as compared to other Cyberchase videos.

Supporting Quotes From Teachers on Children's Reactions re: Fraction Posttest

- Loved it! They connected with Zeus since we talk about him in California History.
- The students seemed to enjoy the video, but not too many of them had a favorite part. They were still talking about the Area video.
- Many of the students said they liked this show the best. They were very amused by the real life segment.

Constructive Quotes From Teachers on Children's Reactions re: Fractions Posttest

- One student commented that she didn't like the program because it contained lying.

Teacher's reaction: Most teachers reported enjoying the fractions video. Others like it but offered suggestions.

Scoring Rubric on Teachers' Reactions: Fractions Posttest

Question	Points	Scoring Rubric
#2 p. 1	1	Overall approval of the program
	2	Approved of the program but offered suggestions or rooms for improvement
	3	Did not approve of the program or offered great criticisms

Supporting Quotes From Teachers on Fractions Posttest

- Good connections to the cross curricular activities. Good basic understanding or introduction to fractions.
- Once again, I appreciated the repetition of the concept.
- I liked the examples give, especially the bars of gold – visual; and I liked the epilogue.

Constructive Quotes From Teachers on Fractions Posttest

- I thought the background knowledge needed to understand the Greek mythology setting was over most third grade students. However, they enjoyed this episode a lot.
- I'm beginning to think the set up part of the video is a little lengthy. 25 minutes is a long time. But, I still like the real life part.
- The show made sense. The one comment that I have about the videos (especially the first one) is that not enough time is spent with the math concepts. While the characters use the concepts several times, I feel like there is so much more going on in the program for them to focus on. I feat that all of the other action may distract them from learning the math.
- I enjoyed it too, but would have liked a bit more mathematical languages such as numerator, denominator, etc. I think the cartoons would be great vehicles for enlarging math vocabulary, which is very important.

Posttest Five: Surveys

An initial examination (by one-way ANOVA) of the Posttest5 variables revealed statistically significant differences by groups as detailed in Table 15:

Table 15
Summary Report of Posttest5 Variables: Surveys

Variable Name	**Sample Size (n)**	**Scoring Direction**	**Possible Range of Scores**	**Actual Range of Scores**	**Mean (s.d.)**
How much did you know about using a survey before watching this Cyberchase show?	445	Low score → better knowledge	1 – 5	1 – 5	2.4 (1.3)
How well did you think you could use a survey before watching this Cyberchase show?	445	Low score → better knowledge	1 – 5	1 – 5	2.2 (1.2)
How much did you like this Cyberchase show?	441	Low score → liked better	1 – 5	1 – 5	1.4 (0.8)
What age group do you think using survey is appropriate for?	444	Low score → younger age	1 – 5	1 – 5	2.9 (0.8)
How much did you learn about using a survey after watching this Cyberchase show?	442	Low score → learned more	1 – 5	1 – 5	1.6 (0.9)

An initial examination (by one-way ANOVA) of the Posttest4 variables revealed statistically significant differences by groups as detailed in Table 16:

Table 16
Group Differences in Posttest5 Variables: Surveys

Variable Name	Sample Size (n)	Grade	Gender	Ethnicity
How much did you know about using a survey before watching Cyberchase?	445	**p = .000** *** (4th Graders know more about using surveys)	n.s.	**p = .002** ** (Asian-Americans know more about surveys)
How well did you think you could use a survey before watching Cyberchase?	445	**p = .003** ** (4th Graders felt better about doing surveys)	n.s.	**p = .001** *** (African-Americans felt better about doing surveys)
How much did you like this Cyberchase show?	441	n.s.	n.s.	n.s.
What age group do you think that using a survey is appropriate for?	444	n.s.	n.s.	**p = .017** * (Caucasian children most felt that the show was aimed at younger children)
How much did you learn about using survey after watching Cyberchase?	442	n.s.	n.s.	n.s.

* $p \leq .05$ ** $p \leq .01$ *** $p \leq .001$

Teacher Comments on Posttest5

Children's reaction: Teachers said their students were largely just as enthusiastic about the survey video as with previous videos.

Scoring Rubric on Teachers' Perceptions of Children's Reactions: Survey Posttest

Question	Points	Scoring Rubric
#1 p. 1	1	Generally or as enthusiastic about the program as compared to other Cyberchase videos
	2	Less enthusiastic about the program as compared to other Cyberchase videos.
	3	More enthusiastic about the program as compared to other Cyberchase videos.

Supporting Quotes From Teachers on Children's Reactions re: Survey Posttest

- Engaged as usual. It's amazing how TV captures their attention. Probably better than I can.
- You timed this one right! The kids were very into this one because of the Halloween tie in.
- Very much glued to the show. Lots of laughter. They like the castle/Halloween theme. Many students pointed out that they used map skills as well as the survey.

Constructive Quotes From Teachers on Children's Reactions re: Survey Posttest

- They seemed a little confused about the concept of a survey. They seemed to want to just ask, "Have you seen Spot?" on their Posttests. I told them they needed to be more specific and describe him.
- I needed to point out the "math" used in this video. We discussed when and where surveys are needed and useful.

Teacher's reaction: Most teachers reported enjoying the survey video. Others like it but offered suggestions.

Scoring Rubric on Teachers' Reactions: Survey Posttest

Question	Points	Scoring Rubric
#2 p. 1	1	Overall approval of the program
	2	Approved of the program but offered suggestions or rooms for improvement
	3	Did not approve of the program or a lot of criticisms

Supporting Quotes From Teachers on Survey Posttest

- I thought you presented how to gather the data well. I have found myself laughing – it is very engaging.
- The show made it very clear that you need to ask specific detailed questions when taking a survey. I liked how the show emphasized that you might need to revise your initial question if you need to gather more or different information.
- I thought the misinterpretation with Dracula was an important part of the show. In addition, I liked the real life example at the end again.

Constructive Quotes From Teachers on Survey Posttest

- I thought this one was rather weak. More emphasis could have been placed on organizing the data (table, graph, tally, etc.), and again, I think there could have been more visuals (show not tell). It was entertaining but not "mathy."

- I didn't like the premise of the epilogue. Kids are already "marketed" by pop-music way too much – sends they the wrong message. You have reinforced that this is appropriate music for young kids. I OBJECT to this very strongly (as a parent too)! This concept of "survey" is not how we usually teach it. Conducting a survey at this age level usually has more to do with presenting information, not in gathering. Not real impressed with this type. I would not use it to introduce concept (although it is entertaining).

Aggregate Posttest

The composite variable scores on the Posttest are presented in Table 17. These variables are sub-categorized by grade, gender, and ethnicity, as were the Pretest composite variable scores (see Table 5).

Table 17
Summary of Posttest Composites[3] by Grade, Gender and Ethnicity

Variable Name	Group/Subgroup	Sample Size (n)	Mean (s.d.)	Group Differences
Child Posttest Math Attitude	Whole Sample	418	19.1 (6.3)	
	Grade 3	204	18.2 (5.3)	**p = .004 **** (3rd graders had a more positive attitude towards math)
	Grade 4	212	20.0 (7.0)	
	Girls	210	19.3 (5.9)	n.s.
	Boys	206	18.9 (6.6)	
	African-American	29	17.4 (5.5)	n.s.
	Asian-American	79	19.1 (6.5)	
	Caucasian	227	19.4 (5.6)	
	Hispanic	72	19.0 (8.2)	
Child Posttest Math Awareness	Whole Sample	416	25.3 (9.9)	
	Grade 3	207	24.0 (9.6)	**p = .004 **** (4th graders had a broader awareness of the scope of math)
	Grade 4	208	26.8 (10.1)	
	Girls	208	25.6 (9.3)	n.s.
	Boys	207	25.1 (10.5)	
	African-American	30	23.9 (9.4)	**p = .02 *** (Caucasian children had the broadest awareness of the scope of math)
	Asian-American	80	24.8 (9.7)	
	Caucasian	224	26.7 (9.3)	
	Hispanic	73	18.4 (11.8)	

* $p \leq .05$ ** $p \leq .01$ *** $p \leq .001$

[3] See Appendix III for details on the construction and components of these variable indices

Table 17 (continued)

Variable Name	Group/Subgroup	Sample Size (n)	Mean (s.d.)	Group Differences
Child Posttest Math Problem Solving Confidence	Whole Sample	393	20.3 (6.6)	
	Grade 3	196	20.1 (6.5)	n.s.
	Grade 4	195	20.4 (6.8)	
	Girls	199	19.9 (6.0)	n.s.
	Boys	192	20.6 (7.3)	
	African-American	29	19.7 (7.2)	**p = .04 *** (Hispanic children had the most self confidence in their Posttest problem solving abilities)
	Asian-American	72	19.7 (5.6)	
	Caucasian	213	21.2 (6.7)	
	Hispanic	68	18.4 (7.1)	
Child Posttest Math Content	Whole Sample	350	11.2 (2.5)	
	Grade 3	190	11.1 (2.2)	n.s.
	Grade 4	160	11.3 (2.8)	
	Girls	173	11.6 (2.5)	**p = .005 **** (Girls scored higher on the Posttest content composite index)
	Boys	177	10.9 (2.4)	
	African-American	24	9.8 (2.2)	**p = .000 ***** (Caucasian children scored highest on the Posttest content composite index)
	Asian-American	65	11.0 (2.9)	
	Caucasian	193	11.8 (2.4)	
	Hispanic	60	10.3 (2.1)	

* $p \leq .05$ ** $p \leq .01$ *** $p \leq .001$

Interpretation

A review of the aggregate Posttest composite variables reveals some group differences. In the Child Posttest Math Attitude revealed that third graders had a more positive attitude. In Child Posttest Math Awareness, fourth graders had a broader sense of the scope of math, and Caucasian children had the broadest awareness of the scope of math. In the Child Posttest Math Problem Solving Confidence, Hispanic children had the most self-confidence in their problem solving abilities.

Teacher Comments on Aggregate Posttest

Children's reaction: All of the teacher responses indicated that students enjoyed the show. A few reported highly enthusiastic viewers who specifically asked to view the show.

Positive Supporting Quotes

- The students enjoyed the videos and have expressed interest in watching the series in January.
- They enjoyed watching them "instead" of math. Had the attitude that this was entertainment.
- They loved them. Some have visited the website. They can't wait for the program to begin in January.

Constructive Quotes

- They enjoyed them very much and always looked forward to seeing the next one. Surprisingly however, they didn't seem to get very attached or connected to any of the characters.

Changes in child attitude toward math: Most teachers observed no appreciable change of attitude toward math related to Cyberchase. However, a small contingent reported increased awareness of math's importance. A few teachers said Cyberchase increased their students' enjoyment of math.

Scoring rubric

Question	Points	Scoring Rubric
#2 p. 1	1	No change observed
	2	Increased enjoyment of math
	3	Increased awareness of math as part of everyday life.

Positive Supporting Quotes

- I think that some students find math more fun and most of the class sees math more as a useful tool rather than a compartmentalized subject.
- I am not sure I would classify it as attitude, but it has opened students' eyes to all the area they use math in.
- A greater interest in math.

Constructive Quotes

- I know they enjoyed the program, but I haven't really seen any changes in their attitudes.
- It's too early to tell if Cyberchase in anyway changed their overall attitude toward mathematics.
- I haven't noticed any change in attitude, except that my students beg to watch Cyberchase. I can use it as an incentive to finish work.

Change in math instruction: Two significant classifications of responses emerged upon reviewing teacher comments. One group of teachers said they would not change their math instruction after watching Cyberchase. However, another group plan to use the videos to supplement instruction. More specifically, these teachers said they would use the videos to introduce, reinforce, and wrap-up lessons.

Scoring rubric

Question	Points	Scoring Rubric
#3 p. 1	1	Will not use videos
	2	Use videos to introduce, reinforce, and/or wrap up lessons

Positive Supporting Quotes

- Cyberchase links education to their own experience; watching cartoons. I'll be sure to explore other math-related videos.
- I like the way the videos explained estimation, area, maps and fractions. I'd use the videos to help introduce these concepts.
- I will use the tapes as an introduction for fractions, etc. (except for survey – not exactly "on the money"). I already try to relate math to students' lives', but will continue to do so.

Constructive Quotes

- No the curriculum will be the same. I might try to use a videotape once in a while.
- Not really, but the videos will be a nice addition.
- No, I wouldn't make any changes since I already incorporate a lot of real life activities into my math teaching, but if these videos were available, I might use some of them to either introduce or sum up a concept.

Change in map instruction: All but a few teacher responses indicated that they would change their map instruction after watching Cyberchase. Some said they would use the videos to introduce and review subject matter. Others said they would include map instruction in social studies lesson plans or introduce more hands-on activities in their mapping lesson plans.

Scoring rubric

Question	Points	Scoring Rubric
#4 p. 2	1	No change in instruction
	2	Use videos to introduce, reinforce, and/or wrap up lessons
	3	Will use the videos to explore new or different instruction strategies

Positive Supporting Quotes

- I may make map learning more of a hands-on activity; such as mapping out the schoolyard.
- I will use Cyberchase to introduce the subject, or as a mid unit review.
- This would also be helpful in my social studies unit on maps.

Constructive Quotes

- The real life application to using a map was very relevant to my class. I do think this show needed to make it clearer that when using maps coordinates, you always give the horizontal one first, then the vertical.
- No, but I will add to what students learned in the video.
- I already teach grid usage with maps and graph art. I feel this is effective.

Change in estimate instruction: Most participants found the estimate video helpful. Some said they would use it to introduce and reinforce estimate concepts. Others cited specific explanations from the video that they plan to use in their lesson plans.

Scoring rubric

Question	Points	Scoring Rubric
#5 p. 2	1	No change in instruction
	2	Use videos to introduce, reinforce, and/or wrap up lessons
	3	Will borrow teaching strategies from the video to improve existing instruction strategies

Positive Supporting Quotes

- Yes, we actually used the example of using our thumb to estimate height. We estimated the height of our classroom using a student.
- I loved this video, and would use it as an intro part I, if I had it. I don't have a great hand on intro for estimation.
- I did like the ideas about teaching estimation that were featured in the movie. I will add the estimation of distance into my program.

Constructive Quotes

- No, I already do many estimation lessons involving real experiences.
- I think I'll reshow this video on estimation when we are further along in multiplication – it will be more relevant to the kids.
- I will not change how I teach, for I first introduce rounding off to tens and hundreds with numbers, before estimating actual sums or remainders.

Change in calculating area instruction: Most participants plan to use the calculating area video to introduce or wrap up lessons. A few reported borrowing teaching strategies to improve existing instruction strategies.

Scoring rubric

Question	Points	Scoring Rubric
#6 p. 2	1	No change in instruction
	2	Use videos to introduce, reinforce, and/or wrap up lessons
	3	Will borrow teaching strategies from the video to improve existing instruction strategies

Positive Supporting Quotes

- This video supports the way I teach calculating area, and I will reshow it when we work on this.
- Yes, I think this is a very abstract concept when taught in the traditional manner. I now have several ideas of how to improve my teaching in this area.
- Yes, the video made the situation realistic for the student. It was in the language a child understands and thus the concept was no longer vague. I would introduce the tape first.

Constructive Quotes

- I won't change that much because I have always used irregular examples of area. We trace our hands and feet on graph paper and calculate fractions of squares.
- Probably not. I use the tiles in the floor and on graph paper for this. Again, I'd be glad to show the video, too. It adds more fun!

Change in fraction instruction: Most participants plan to use the fraction video to introduce or wrap up lessons. A few responses indicated that they would not change their teaching strategies after watching the fraction video.

Scoring rubric

Question	Points	Scoring Rubric
#7 p. 3	1	No change in instruction
	2	Use videos to introduce, reinforce, and/or wrap up lessons
	3	Will borrow teaching strategies from the video to improve existing instruction strategies

Positive Supporting Quotes

- Already doing this, yet the video gives the students the visuals and interesting background to begin to develop their concepts in this area.
- I will use the video to enhance my curriculum and refer to it often.
- I like how they taught fractions in the movie. I already use food and manipulatives and am comfortable continuing to teach fractions in this way.

Constructive Quotes

- I thought the concept of switching from picture to fraction happened fast. This video might be a good follow up to teaching fractions.
- Of all the shows, I thought fractions needed to be divided into smaller segments – it tried to cover too many concepts relating to fractions in one show.
- No, I have always taught fractions using story lines where things needed to be divided up into equal portions that didn't include just whole numbers.

Change in survey instruction: Most participants plan to use survey video to introduce or wrap up lessons. Other teachers said they would borrow ideas from the video to use in their own lessons. A few responses indicated that they would not change their teaching strategies after watching the fraction video.

Scoring rubric

Question	Points	Scoring Rubric
#8 p. 3	1	No change in instruction
	2	Use videos to introduce, reinforce, and/or wrap up lessons
	3	Will borrow teaching strategies from the video to improve existing instruction strategies

Positive Supporting Quotes

- Yes, I love the survey strategies. I usually start this strand with graphing “like” and “dislikes.” I loved the way Cyberchase used surveys to help solve a problem.
- Another good follow up to teaching a survey lesson.
- I think I will use actual surveys that are student generated to deal with graphs and statistics. This approach seemed to make lots of sense to the kids.

Constructive Quotes

- This was my least favorite. I did not see a lot of math strategies here.
- I am always looking for ways to improve my teaching…However, I don’t think Cyberchase has affected the approach I will take in teaching a concept. Like I said earlier, I may use the video as a tool for enhancement, but I didn’t see anything that would lead me to change.
- In third grade, we mostly use surveys to gather information for graphing. I will introduce surveys as a means of gathering other types of information such as what kinds of questions you would need to ask when looking for a lost pet.

Overall Comments

- I liked the fact that the girl characters were strong in mathematical concepts. This is key. Many girls in my class are afraid of math already (very sad) and lack confidence. Good role models.

- The pre and Posttests were extremely long, especially for 3rd graders.

- I hope the producers will consider cutting the amount of name calling in future episodes. While the children think it is "funny" it is not the type of behavior we want to see modeled on television.

- I think they would make more of an impression if kids had some background knowledge of the concepts or if they were reinforced after the video in class. You might see better results if the videos were used during more appropriate times (e.g. Not in a 2 week time frame).

Table 18
Pretest - Posttest Correlations among Variable Indices

	A Pretest: Baseline General Math Attitude r (n)	B Pretest: General Math Attitude r (n)	C Pretest: Aware-ness of Scope of Math r (n)	D Pretest: Problem Solving Confi-dence r (n)	E Pretest: Content Question Scores r (n)	F Posttest: General Math Attitude r (n)	G Posttest: Awareness of Scope of Math r (n)	H Posttest: Problem Solving Confi-dence r (n)	I Posttest: Content Question Scores r (n)
A	1.00 (430)								
B	**.43***** (423)	1.00 (435)							
C	-.20 (388)	**-.16***** (393)	1.00 (406)						
D	**.25***** (428)	**.45***** (433)	**-.12*** (404)	1.00 (448)					
E	.07 (411)	.01 (416)	.02 (360)	**-.14**** (429)	1.00 (450)				
F	**.21***** (381)	**.42***** (387)	.03 (360)	**.20***** (398)	-.01 (400)	1.00 (418)			
G	.07 (381)	**-.13**** (387)	**.44***** (361)	**-.12**** (398)	**.18***** (400)	.01 (377)	1.00 (416)		
H	**.17***** (361)	**.33***** (366)	-.02 (347)	-.10 (354)	**-.10*** (354)	**.66***** (377)	-.02 (377)	1.00 (393)	
I	**.12**** (324)	.03 (329)	**.36***** (308)	-.09 (340)	-.04 (350)	.04 (313)	**.25***** (315)	.07 (298)	1.00 (350)

* p ≤ .05 ** p ≤ .01 *** p ≤ .001

A correlation matrix between variables is one way to look at the relationships between variables. This matrix (Table 18) correlates the Pretest and Posttest composite variables with each other. The matrix is shaded to help differentiate the Pretest and Posttest variables. The significance levels are reported as "one-tailed" as the hypotheses made were only for change in a positive direction directional. As expected, each variable, when correlated with itself, generates a perfect score of 1.0. Table 23 presents a correlation matrix of the variables from each of the Posttests. This is the darkest shaded section of the matrix in Table 18.

Table 19 provides a comparison of Posttests across episodes. We can clearly see that:

- The children knew the least about surveys before watching any episodes, and the most about area and navigation
- The children felt least confident about the doing a survey before watching the episodes and most confident about doing navigation, estimation and fractions
- The children seem to like each of the episodes about the same amount
- The children thought that navigation and surveys were meant for children their own age, and that estimation, area, and fractions were for slightly younger children.
- The children seemed to feel that they learned about the same amount from each of the episodes

Table 19
Posttest Comparison across Episodes

Variable	Navigation Mean (s.d)	Estimation Mean (s.d)	Area Mean (s.d.)	Fractions Mean (s.d.)	Surveys Mean (s.d.)
How much did you know about …?	2.0 (1.0)	1.8 (0.9)	2.0 (1.1)	1.9 (1.0)	2.4 (1.3)
How well did you think you could …?	1.9 (0.9)	1.9 (0.9)	2.0 (1.0)	1.9 (0.9)	2.2 (1.2)
How much did you like this Cyberchase show?	1.3 (0.7)	1.3 (0.7)	1.4 (0.8)	1.4 (0.7)	1.4 (0.8)
What age group do you think that ….?	2.9 (0.9)	2.7 (0.8)	2.7 (0.8)	2.7 (0.7)	2.9 (0.8)
How much did you learn about…?	1.7 (1.0)	1.7 (1.0)	1.8 (1.1)	1.8 (1.1)	1.6 (0.9)

Table 20 outlines the sample's enjoyment of the Cyberchase characters. The character receiving the largest "a lot" percentage of the sample was Digit (83%), followed by Matt (79%) and Jackie (70%). Other details are outlined in Table 20. The data is also presented graphically in Figure 16 (next page).

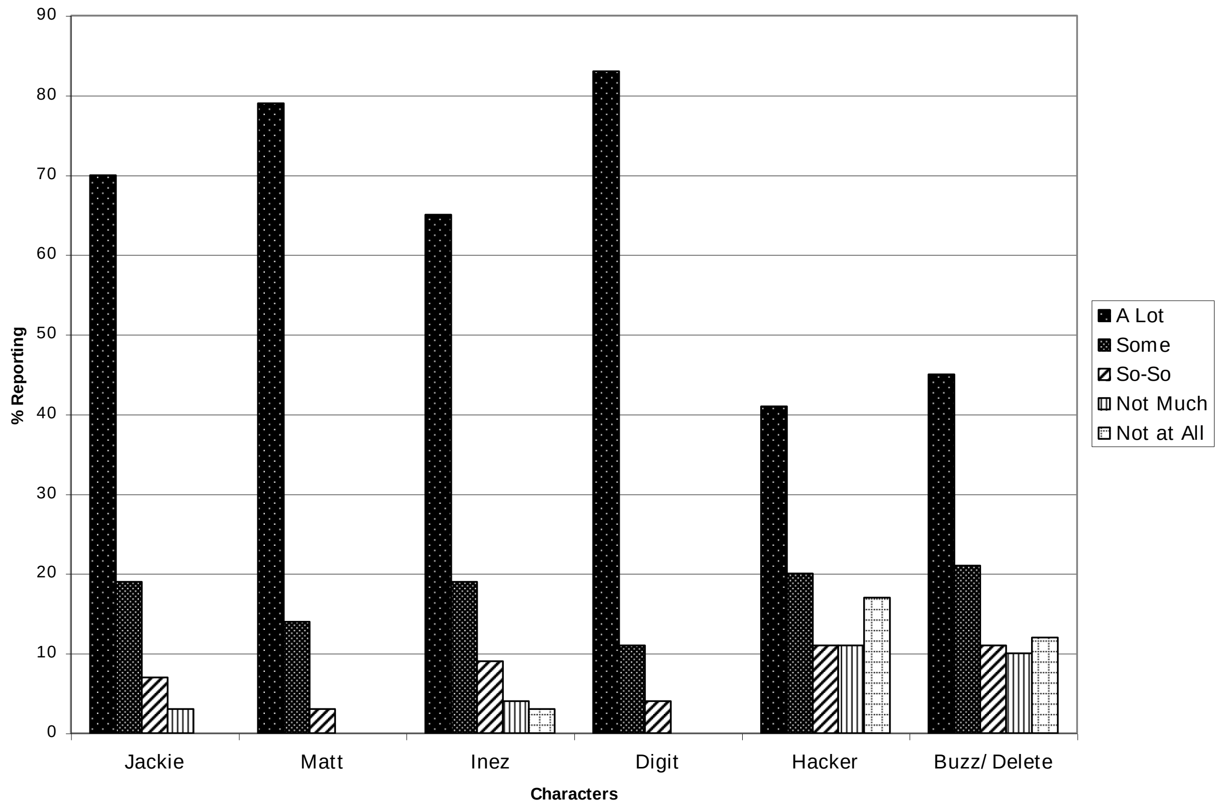
Table 20
Sample's Enjoyment of Cyberchase Characters[4]

Character	Most Common Descriptor (%)	2nd Descriptor (%)	3rd Descriptor (%)	4th Descriptor (%)	5th Descriptor (%)
Jackie	A Lot (70)	Some (19)	So-So (7)	Not Much (3)	---
Matt	A Lot (79)	Some (14)	So-So (3)	---	---
Inez	A Lot (65)	Some (19)	So-So (9)	Not Much (4)	Not At All (3)
Digit	A Lot (83)	Some (11)	So-So (4)	---	---
Hacker	A Lot (41)	Some (20)	Not At All (17)	So-So (11)	Not Much (11)
Buzz & Delete	A Lot (45)	Some (21)	Not At All (12)	So-So (11)	Not Much (10)

[4] Only percentages greater than 2% are reported

Figure 16 is a bar chart that shows the results in Table 20 in a graphical format.

Figure 16
Sample's Enjoyment of Cyberchase Characters



In the Posttest we asked the children to indicate which of the characters they would choose to help them solve a problem (multiple choices were allowed). Matt received the greatest percentage of the sample's vote (77%). The results for each character are presented in Table 21. The data is also presented graphically in Figure 17 (following page).

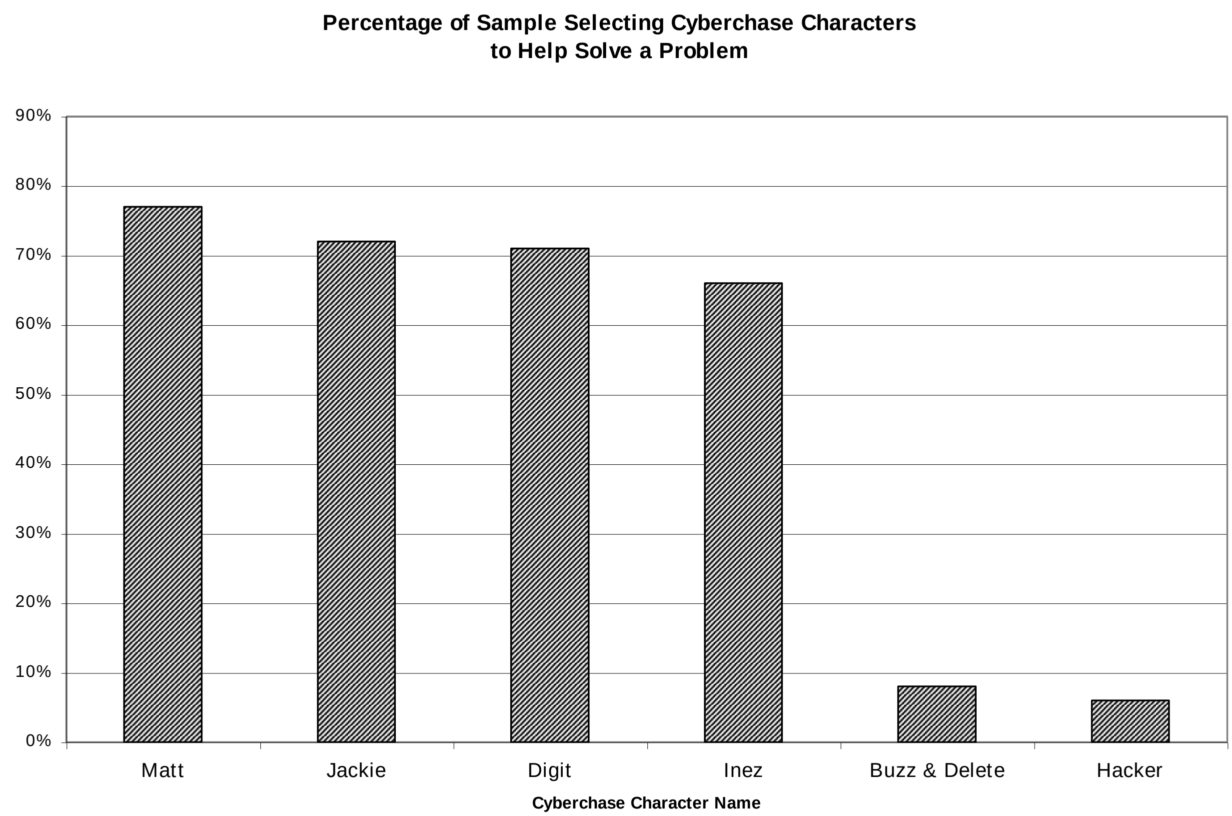
Table 21
Sample's Choice of Cyberchase Characters to Help Solve a Problem[5]

Character	Sample (%) Who Selected this Character
Matt	77%
Jackie	72%
Digit	71%
Inez	66%
Buzz & Delete	8%
Hacker	6%

[5] Respondents could select more than one character

The data from Table 21 (previous page) are presented graphically in Figure 17.

Figure 17



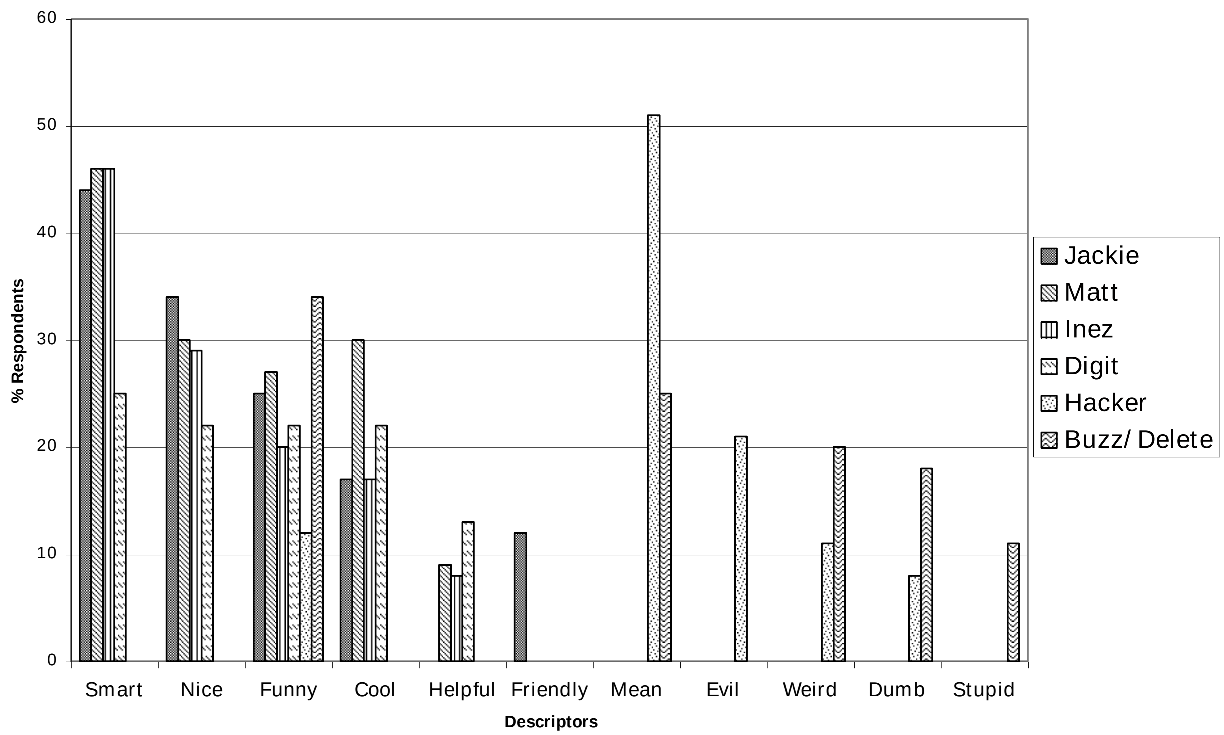
The sample was asked to list as many words as they could think of about each character. The findings are presented in Table 22. The word most used to describe Jackie, Matt and Inez was "smart", and the second most common word was "nice". Both Digit and Buzz & Delete were described as "funny" and Hacker as "mean". Further details provided in the table below. The results are presented graphically in Figure 18 (next page).

Table 22
Sample's Descriptions of Cyberchase Characters

Character	Most Common Descriptor (%)	2nd Descriptor (%)	3rd Descriptor (%)	4th Descriptor (%)	5th Descriptor (%)
Jackie	Smart (44)	Nice (34)	Funny (25)	Cool (17)	Friendly (12)
Matt	Smart (46)	Nice (30)	Cool (30)	Funny (27)	Helpful (9)
Inez	Smart (46)	Nice (29)	Funny (20)	Cool (17)	Helpful (8)
Digit	Funny (52)	Smart (25)	Cool (22)	Nice (22)	Helpful (13)
Hacker	Mean (51)	Evil (21)	Funny (12)	Weird (11)	Dumb (8)
Buzz & Delete	Funny (34)	Mean (25)	Weird (20)	Dumb (18)	Stupid (11)

Figure 18 presents the data from Table 22 (previous page) in graphical format.

Figure 18
Sample's Descriptions of Cyberchase Characters



A correlation matrix between variables is one way to look at the relationships between variables. This matrix (Table 23) correlates the Posttest composite variables with each other. The significance levels are reported as "one-tailed" as the hypotheses made were only for change in a positive direction directional. As expected, each variable, when correlated with itself, generates a perfect score of 1.0. Statistically significant correlations are noted in **bold**.

The following statements hold true for the Posttest variable correlations:

- Posttest math attitude is positively correlated with Posttest math problem solving confidence
- Posttest math awareness is positively correlated with Posttest math content scores

Table 23
Intercorrelations between Posttest Composite Variable Indices[6]

	Child Posttest General Math Attitude r (n)	Child Posttest Math Awareness r (n)	Child Posttest Math Problem Solving Confidence r (n)	Child Posttest Math Content r (n)
Child Posttest General Math Attitude	1.00 (418)			
Child Posttest Math Awareness	.01 (377)	1.00 (416)		
Child Posttest Math Problem Solving Confidence	**.66***** (377)	-.02 (377)	1.00 (393)	
Child Posttest Math Content	.04 (313)	**.25***** (315)	.07 (298)	1.00 (350)

$^{*}\ p \leq .05$ $^{**}\ p \leq .01$ $^{***}\ p \leq .001$

[6] See Appendix III for details on the construction and components of these variable indices

The Posttest composite variable summaries are presented in Table 24. A "?" indicates that there was no maximum upper range for the variable.

Table 24
Summary Report of Posttest Composite Variable Indices[7]

Variable Name	Scoring Direction	Sample Size (n)	Number of Variables in Index	Possible Range of Scores	Actual Range of Scores	Mean (s.d.)
Child Posttest General Math Attitude	Low score → more positive attitude	418	11	11 - 55	10 - 50	19.1 (6.2)
Child Posttest Math Awareness	High score → broader awareness	416	21	0 - ?	3 - 88	25.7 (10.0)
Child Posttest Math Problem Solving Confidence	Low score → more self-confidence	393	12	12 -60	8 – 48	20.2 (6.6)
Child Posttest Math Content	High score → better content grasp	350	5	0 – 20	0 – 18	11.2 (2.5)

[7] See Appendix III for details on the construction and components of these variable indices

Table 25 presents the findings from the teacher Posttest. The scoring rubrics were created to make the scoring hierarchical from most teacher directed to most child directed. The same trained team of coders who did the coding for the child instruments scored each of the teacher instruments. There were no statistically significant differences in teacher Pretest (baseline) philosophies between 3rd and 4th grades. It might be interesting to construct a composite index of teaching philosophies in the next phase of the study. This could be compared statistically to a composite index of teaching philosophies from the Posttest.

Table 25
Teacher Comments on Cyberchase Episodes

Variable Name	Sample Size (n)	Scoring Direction	Possible Range of Scores	Actual Range of Scores	Mean (s.d.)
Philosophy of how children learn	19	No specifics → sequenced learning	1 – 5	1 – 5	2.7 (1.3)
Philosophy of how children learn math	19	No specifics → sequenced learning	1 – 5	1 – 5	2.8 (1.3)
Instructional practices in math	19	No specifics → sequenced learning	1 – 5	1 – 5	3.0 (1.3)
Instructional practices in maps	19	Teacher directed → individual instruction	1 – 5	1 – 3	2.2 (0.6)
Instructional practices in estimation	19	No specifics → sequenced learning	1 – 5	1 – 5	2.3 (1.4)
Instructional practices in area	19	No specifics → sequenced learning	1 – 5	1 – 5	2.7 (1.2)

Table 25 (continued)

Variable Name	Sample Size (n)	Scoring Direction	Possible Range of Scores	Actual Range of Scores	Mean (s.d.)
Instructional practices in fractions	19	No specifics → sequenced learning	1 – 5	1 – 5	2.2 (1.4)
Instructional practices in surveys	19	No specifics → sequenced learning	1 – 5	1 – 5	3.1 (2.0)

FINDINGS

Research Question One

1. **Do children have more positive attitudes about doing math after T_x?**
   - 1a. Do these T_x effects differ by gender?
   - 1b. Do these T_x effects differ by grade?
   - 1c. Do these T_x effects differ by ethnicity?

Attitudes about doing math improved significantly after viewing five episodes of Cyberchase. Children's attitudes improved, to a statistically significant degree, across grade level, gender, and all four ethnic groups.

An examination (by paired-sample t-test) revealed an overall statistically significant difference between children's Pretest and Posttest attitudes about doing math after watching Cyberchase. There was an increase in the general math attitude. Table 26 provides the results of the t-test for a change in math attitude from Pretest to Posttest.

Table 26
Paired Sample T-Test on Math Attitudes

Variable Name	Sample Size (n)	t-test	significance
Pretest General Math Attitude	387	6.81	**.000 *** **
Posttest General Math Attitude			

Table 27 provides the results from an examination of group changes. After watching Cyberchase, the children showed an overall and statistically significant positive change in their interest in and attitudes about doing math. Both 3rd and 4th graders showed an increase in positive math attitudes. Both girls and boys showed an increase in positive math attitudes. African-American, Asian-American, Caucasian, and Hispanic children also all showed a statistically significant increase in positive math attitudes.

Table 27
Group Differences in Math Attitude

Group	Group Components	Sample Size (n)	t-test	significance
Gender	Girls	195	3.96	**.000 *****
	Boys	191	5.94	**.000 *****
Grade	3rd Grade	194	7.24	**.000 *****
	4th Grade	192	3.18	**.002 ****
Ethnicity	African-American	29	2.69	**.01 ****
	Asian-American	75	3.02	**.003 ****
	Caucasian	211	4.89	**.000 *****
	Hispanic	62	2.54	**.01 ****

* $p \leq .05$ ** $p \leq .01$ *** $p \leq .001$

Research Question Two

2. **Do children have greater awareness about the scope of math after T_x?**

   2a. Do these T_x effects differ by gender?

   2b. Do these T_x effects differ by grade?

   2c. Do these T_x effects differ by ethnicity?

Children's awareness of the scope of math tended to show an increase after viewing Cyberchase. Although not statistically significant, there was evidence that the children's awareness of math broadened after viewing Cyberchase.

An examination (by paired-sample t-test, Table 28) revealed no overall statistically significant difference between the Pretest and Posttest awareness about the scope of math after watching Cyberchase. Group differences were therefore not examined.

Table 28
Paired Sample T-Test on Math Awareness

Variable Name	Sample Size (n)	t-test	significance
Pretest General Math Awareness Posttest General Math Awareness	361	.77	n.s.

* $p \leq .05$ ** $p \leq .01$ *** $p \leq .001$

Research Question Three

3. Do children have greater self-confidence/interest in problem solving after T_x?

3a. Do these T_x effects differ by gender?

3b. Do these T_x effects differ by grade?

3c. Do these T_x effects differ by ethnicity?

Self-confidence about solving math problems improved significantly after viewing Cyberchase. Children's self-confidence improved, to a statistically significant degree, across grade, gender, and all ethnic groups.

An examination (by paired-sample t-test, Table 29) revealed an overall statistically significant difference between the Pretest and Posttest self-confidence in problem solving skills after watching Cyberchase. There was an increase in self-confidence about problem solving skills.

Table 29
Paired Sample T-Test on Self-Confidence in Problem Solving

Variable Name	Sample Size (n)	t-test	Significance
Pretest Self-Confidence in P.S.	377	4.56	**.000** ***
Posttest Self-Confidence in P.S.			

Table 30 provides the results from an examination of group changes. After watching Cyberchase, the children showed an overall and statistically significant positive change in their self-confidence in problem solving. Both 3rd and 4th graders showed an increase in self-confidence in problem solving. Both girls and boys showed an increase in self-confidence in problem solving. African-American, Asian-American, Caucasian, and Hispanic children also all showed a statistically significant increase in self-confidence in problem solving.

Table 30
Group Differences in Self-Confidence in Problem Solving

Group	Group Components	Sample Size (n)	t-test	Significance
Gender	Girls	192	4.25	**.000 *****
	Boys	184	2.74	**.007 ****
Grade	3^{rd} Grade	189	3.80	**.000 *****
	4^{th} Grade	187	2.66	**.009 ****
Ethnicity	African-American	29	1.96	**.05 ***
	Asian-American	71	2.07	**.04 ***
	Caucasian	204	2.42	**.02 ***
	Hispanic	63	3.07	**.003 ****

* $p \leq .05$ ** $p \leq .01$ *** $p \leq .001$

Research Question Four

4. **Do children have greater comprehension/understanding of content after T_x?**

4a. Do these T_x effects differ by gender?

4b. Do these T_x effects differ by grade?

4c. Do these T_x effects differ by ethnicity?

Content knowledge about math improved significantly after viewing Cyberchase. For each of the individual programs viewed, content knowledge improved, to a statistically significant degree, for all groups represented.

An examination (by paired-sample t-test, Table 31) revealed an overall statistically significant difference between the Pretest and Posttest content knowledge after watching Cyberchase. There was an increase in content knowledge.

Table 31
Paired Sample T-Test on Content Comprehension

Variable Name	Sample Size (n)	t-test	significance
Pretest Math Content	350	-5.26	**.000** ***
Posttest Math Content			

Table 32 provides the results from an examination of group changes. After watching Cyberchase, the children showed an overall and statistically significant positive change in their content knowledge. Both 3rd and 4th graders showed an increase in content knowledge. Both girls and boys showed an increase in content knowledge. African-American, Asian-American, Caucasian, and Hispanic children also all showed a statistically significant increase in content knowledge.

Table 32
Group Differences in Content Comprehension

Group	Group Components	Sample Size (n)	t-test	significance
Gender	Girls	173	-4.67	**.000 *** **
	Boys	177	-2.75	**.007 ** **
Grade	3^{rd} Grade	190	-5.65	**.000 *** **
	4^{th} Grade	160	-1.90	**.05 * **
Ethnicity	African-American	24	-.73	.47
	Asian-American	65	-1.15	.25
	Caucasian	193	-5.62	**.000 *** **
	Hispanic	60	-1.86	.07

* $p \leq .05$ ** $p \leq .01$ *** $p \leq .001$

Conclusion

Both the children and teachers were enthusiastic about the appeal and value of the programs. The children were engaged by the characters, story, and content. Teachers believed the series supported math instruction in the third and fourth grade classrooms, even though the series is designed for out-of-school viewing. Our study suggests that this series will appeal to and positively influence children's attitudes, self-confidence and math content knowledge. We found no notable differences in the results between boys and girls, between third and fourth graders, and among the various ethnic groups in our sample. Our findings support that viewing Cyberchase had a positive influence on children and their engagement with mathematics ideas. This study was less comprehensive than the one to be conducted in the spring, one that will include broadcasts, a website, and print materials for both children and their parents.

Appendix I: Announcement to Recruit Sites

3rd & 4th Grade Math Teachers

This is an invitation to preview with your class a series of standards-based, animated adventure math videos, geared for eight to eleven year olds. These videos will be part of a groundbreaking adventure televised series called "Cyberchase". We are looking for teachers of 3rd and 4th grade who would enjoy showing five episodes of Cyberchase's program prior to the on-air debut in 2002. In addition to having an advance viewing, each participating class will receive a digital camera valued at approximately $200. These episodes are co-produced by WNET, the nation's flagship public television station, and Nelvana (a leading integrated children's entertainment company that produces *Little Bear* and *Franklin*). The findings from this study will be used to develop additional episodes. From the same producer as Magic School Bus, and involving award-winning writers, producers and content experts, these episodes are both fun and educational. Famous voices include Christopher Lloyd (the Emmy Award-winning actor best known as Doc Brown in *Back to the Future*) and comedian, Gilbert Gottfreid. The three heroes use brainpower to take on Hacker who wants to rule cyberspace. Cyberchase is designed to further the national goal of advancing math competence for all America's children.

ROCKMAN *ET AL*, an independent research and consulting firm specializing in education and technology, is working with WNET on this project. We estimate the total time commitment for teachers and their classes to be five (5) hours. The episodes will be provided on video and would need to be shown during the first weeks of October. Therefore, if you are interested, please respond as soon as possible in order to secure your chance to participate. You may call 1-800-410-2820 or email us. Thank you!

Anne Fetter anne@rockman.com and Nicole Presber nicole@rockman.com
http://www.rockman.com

Appendix II: Calendar of Treatment Implementation

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
				4	WNET materials to Rockman ("REA") 5	6
7	Distribute materials to sites. 8	Materials arrive on site. 9	Pretest given. Demog. collection. Consent forms. 10	11	TAPE 1 Posttest 1 Pretest and demog. arrive REA 12	13
14	TAPE 2 Posttest 2 15	Posttest 1 arrives REA 16	TAPE 3 Posttest 3 Posttest 2 arrives REA 17	18	TAPE 4 Posttest 4 Posttest 3 arrives REA 19	20
21	TAPE 5 Posttest 5 22	Posttest 4 arrives REA 23	Posttest 5 arrives REA 24	25	26	27
28	Implement Posttest 29	30	Posttest arrives REA 31	1	2	3
4	5	6	7	8	**Report to WNET** 9	

Appendix III: Construction of Variable Indices[8]

Index Label	Source of Variables	Variable Name	Components and Construction[9]
Child Pretest General Math Attitude **Low score = more positive attitude**	Pretest	CATTGENA[10] CATTA	CPLIKEA + CFHELPA + CGAMESA + CHELPCMA + CPDESCRA + CTHLPMA + CCOMPCMA + CTDESCRA CFUNA + CESYPRBA + CHRDPRBA + CLIKEA + CFUSEA + CFIGUREA + CINTRSTA + CUSEFULA + CSELFA + COTHERSA + CEASYA +
Child Pretest Math Awareness **High score = broader awareness**	Pretest	CAWAREA[11]	CWORDSA + CWHENA + CDOMAPA + CDOCODEA + CDOMULTA + CDOPATA + CDOESTA + CDOMEASA + CDOSUBA + CDOSPLTA + CDOSHPA + CDOPIZZA + CDOTRIA + CEXPCONA + CACCAKEA + CACDOGA + CACKITEA + CACMATHA + CACQLTA + CACSTORA + CEXPACTA
Child Pretest Math Problem Solving Self-Confidence **Low score = more self-confidence**	Pretest	CPSSCA	CADDA + CDIVIDA + CCHARTA + CBOOKA + CCOLORA + CRIDDLA + CCROSSA+ CESYOWNA + CEASYFRA + CHELPFRA + CHRDOWNA + CHRDFRA
Child Pretest Math Content **High score = better content grasp**	Pretest	CCONTA	CNAVIGA + CESTIMA + CAREAA + CFRACTA + CSURVEYA

[8] Please refer to the Codebook (Vol III) for details.
[9] The variables are all listed by name in this order in the codebook.
[10] These variables are only included in the Pretest as a measure of attitude that is not expected to change over the treatment period. There is no corresponding variable for the Posttest
[11] The variables that were not related to math as specified by WNET were not included in this index.

Index Label	Source of Variables	Variable Name	Components and Construction[12]
Child Posttest General Math Attitude **Low score = more positive attitude**	Posttest	CATTB	CFUNB + CESYPRBB + CHRDPRBB + CLIKEB + CFUSEB + CFIGUREB + CINTRSTB + CUSEFULB + CSELFB + COTHERSB + CEASYB
Child Posttest Math Awareness **High score = broader awareness**	Posttest	CAWAREB[13]	CWORDSB + CWHENB + CDOMAPB + CDOCODEB + CDOMULTB + CDOPATB + CDOESTB + CDOMEASB + CDOSUBB + CDOSPLTB + CDOSHPB + CDOPIZZB + CDOTRIB + CEXPCONB + CACCAKEB + CACDOGB + CACKITEB + CACMATHB + CACQLTB + CACSTORB + CEXPACTB
Child Posttest Math Problem Solving Self-Confidence **Low score = more self-confidence**	Posttest	CPSSCB	CADDB + CDIVIDB + CCHARTB + CBOOKB + CCOLORB + CRIDDLB + CCROSSB+ CESYOWNB + CEASYFRB + CHELPFRB + CHRDOWNB + CHRDFRB
Child Posttest Math Content **High score = better content grasp**	Posttest	CCONTB	CNAVIGB + CESTIMB + CAREAB + CFRACTB + CSURVEYB

[12] The variables are all listed by name in this order in the codebook.

[13] The variables that were not related to math as specified by WNET were not included in this index.

Appendix IV: Notes on Coding of Content Questions

Navigation

In general the answers on the Pretest did not provide much in the way of rationale, though the concept was undoubtedly present (generally scored a 2) and explanation is necessary to score in the 3 or 4 range. On the Posttests the number of 2 scores (correct answer, no explanation) seemed to rise considerably. In both the Pretest and Posttest most respondents were able to determine the grid coordinates (d, 1), and more than a few made reference to the actual grid (terms like across and down indicate a deeper comprehension of the concept, matching the letters and mentioning "following lines", which would correspond to x and y coordinates on a two-dimensional grid). Few children did not make use of the grid coordinates, and opted to state its position relative to the other items on the island (generally scored a 1). References to the spider also are indicative of the use of a two-dimensional grid (generally scored a 2). A few children made use of the cardinal directions, indicating a familiarity with mapping skills and the tendency to place north on top, south on the bottom, and west on the left, etc. (generally scored a 3). Children who referenced the superimposed grid (generally scored 3 or 4), perhaps an indication of that as well as knowledge of two-dimensional coordinate systems (generally scored a 4).

Estimation

A relatively small number of respondents guessed haphazardly or did not respond on the Pretest (scoring 0 or 1). Up to 30% of the respondents on the Pretest and a slightly smaller percentage on the Posttest did not make an "estimate", but instead opted to count the bricks thereby arriving at a reasonable estimate (generally scoring 2, regardless of how accurate it was), and the respondents almost invariably indicated their methodology in this case. Some evidence of mathematical reasoning was necessary to score 3, multiplying the number of bricks on the side by the number of bricks on the top, and arriving at a "good" estimate. Any sign of multiplication (either 11x7, 12x8, or 12x7) was considered mathematical reasoning, despite lack of explanation, by virtue of representing the necessary product to accurately determine bricks in the given area. A score of 4 required the necessary mathematical explanation and computation. The actual computation involved was allowed to be either 12x7, 11x7, or 12x8 due to differing numbers of bricks in the top and bottom rows and the presence of partial bricks. A good number of students correctly identified the necessary elements to make an accurate estimate, but failed to arrive at the correct product through mathematical defect….e.g., "there are 7 bricks on the side and 11 on top, you times the numbers and get 50, so my answer is 50." This was generally scored one point less from 3 to 2. The number of respondents who exhibited knowledge of the relevant concept was markedly higher on the Posttest, regardless of mathematical defect in obtaining a final answer.

Area

The external dots in the figure provided confused a number of respondents on the Pretest, who counted them and incorrectly equated that sum with the area in question (the concept of "area" being clearly confused with the perimeter of the larger shape, yielding a wrong answer of 12 or

14 shapes). This was scored 1 in general, and there was considerably less confusion on the Posttest. A number of respondents correctly guessed 10 smaller shapes with absolutely no explanation or drawing which begs the question: was the answer was somehow disseminated for general consumption in certain classrooms on both the Pretest and Posttest? Most of the students who arrived at the correct answer connected the dots inside of the larger shape, noticing this created a number of smaller shapes nearly identical to the original in question, and correctly counted them to be 10. In the absence of explanation this was scored a 3, in as much as connecting the dots inside the larger shape was construed as grasping the concept of area and correctly assessing the relationship of the external dots provided and the smaller shape. A score of 4 was rare on the Pretest, as an explanation was required. A few more respondents on the Posttest provided a brief explanation, such as "I connected the dots and counted the squares inside". The most remarkable change on the Posttest came from the number of respondents who manipulated the irregular shape into a rectangle or square in order to determine its area in terms of the smaller shape by using the same formula necessary in question #2 involving the bricks. This was scored a four without exception as it evidenced advanced and abstract knowledge of geometry and area. There was not an instance of a respondent manipulating the shape as such in the Pretest.

Fractions

Very few students did not draw on the picture as requested, and such drawings were weighted equally with sound reasoning in the scoring of this question. The concept of fractions was not evident in a few respondents who correctly drew one cupcake cut in half, but then indicated each of the two hypothetical friends would receive 2 cupcakes each, 1 each, or 3 each. This was scored as a 1. A fairly large number of respondents split each of the three cupcakes in half, stating the hypothetical friends would then each receive three pieces (in effect 3/6, or 1/2) which was considered correct and scored a 2 as it accurately divided the three cupcakes (I suspect that a number of respondents assumed each cupcake was unique and therefore needed to be split, which I determined was a more significant factor than not reducing a fraction to its least common denominator). One and a half was expressed fractionally less often than its rhetorical counterpart, e.g., "we each get one and split the middle one". This was scored a 2 for the most part. 3/2 was seldom seen, and the concept of fractions was seldom mentioned. Accurate drawings were scored 3 in many cases without much accompanying explanation, though scores of 4 were not given without a drawing and relevant mention of fractions. The question undoubtedly led many respondents astray—"splitting the cupcakes", a common answer on the both the Pretest and Posttest, largely supplanted any recognition of the concept of fractions. There did not seem to be much variance between Posttest and Pretest scoring.

Data

A good deal of respondents were unable to provide answers in the form of hypothetical questions, as the abstract reasoning necessary was absent. This probably prevented them, despite the fact that they were able to draw the necessary distinctions between the three dogs, from responding with the pertinent information or in the desired manner. The relatively large number of 0 and 1 scores (largely comprised of irrelevant responses) may be attributed to this. Related to this, a few respondents provided accurate statements with the distinguishing characteristics of each dog. This was scored a 3, but not a 4. A good number of respondents identified the dogs with , and that reference was considered tantamount to having spots for the purposes of scoring this question. A concise response such as “Have you a seen a dog with spots and collar?” would have been scored 4 as it evidences the complex and abstract reasoning desired. Not much variance seemed evident between Pretest and Posttest scoring.