Cyberchase
Phase II Field Evaluation
Spring 2002

The Television Show and the Website

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by

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EXECUTIVE SUMMARY

Cyberchase is an animated math adventure Television Series on PBS with an accompanying Website that extends the reach of the program through various interactive activities. The goal of Cyberchase is to improve children's general attitude, and self-confidence about mathematical problem solving, particularly among girls and ethnic minority groups. The focus of this naturalistic study was to explore the enjoyment and appeal of Cyberchase, and its influence on children's attitudes about math, self-confidence about mathematical problem solving, patterns of Website use, mathematical problem solving skills, and content recall.

Highlights of Findings

Cyberchase was very popular with the 3rd and 4th grade children in our sample. The more children engaged with Cyberchase, the more they enjoyed it, and the more they reported that it helped them with math and problem solving skills. Cyberchase is especially appealing to the younger children in the target audience, to girls, and to Hispanic children. Children enjoyed both Cyberchase's animated and the "For Real" segments. One of the strengths of Cyberchase is that the characters think, and that sustains interest in the Series. The Website has great appeal. Nearly two-thirds of site visitors stay an hour or more; the site has extraordinary "stickiness." Highlights of the findings are presented below; all scores are based on responses scored on a 5-point rating scale. All findings presented below are statistically significant. In addition to reporting the average score for these questions, we have converted the relevant scores to a percentage appeal rating (actual score as a percentage of the maximum score of five).

Program Enjoyment and Appeal

Children enjoyed Cyberchase's animated segments (an 82% appeal rating) and "For Real" segments (78% appeal rating). Regular viewers rated it even higher. The more children engaged with Cyberchase, the more they liked the it. Cyberchase skews towards the younger children in the target audience, girls, and children of Hispanic descent. The characters are appealing and children identify with the heroes. Jackie and Matt have a 92% appeal rating, Digit a 90% appeal rating, and Inez an 88% appeal rating.

Attitude About Mathematics

Children had a positive attitude about mathematics overall (4.2 based on a 5-point scale). The more children engaged with Cyberchase, the more positive their attitude about mathematics. Younger children in the study have a more positive attitude than older children, and girls have a more positive attitude than boys. Hispanic children had a more positive attitude about mathematics than Caucasian children. Children who engaged more with Cyberchase had a more positive attitude (Low < Medium < High).

Self-Confidence About Mathematical Problem Solving

Children reported high self-confidence about problem solving overall (4.3). The more children engaged with Cyberchase, the better their self-confidence about problem solving (Low < Medium < High). Younger children have more self-confidence than older children, and girls have more self-confidence than boys in solving mathematical problems. Hispanic children in our sample are more self-confident about mathematical problem solving than Caucasian children.

Website Use

About one-third (31%) of the sample reported visiting the Cyberchase Website, a finding that was consistent across grade and gender. About half of the children report no Internet access at home. When the children visit the Website, nearly two-thirds (65%) of them stay an hour or more, an extraordinary length of time for this age group and this kind of Website content. The more children engaged with Cyberchase, the more helpful they found the Website to be with both math and problem solving.

Mathematical Problem Solving

Of the children who visited the Cyberchase Website, 82% feel that it helped them with their math skills, and 72% feel that it helped them with their problem solving skills. Although we were not able to confirm statistically, there appears to be a trend towards better problem solving skills and increased engagement with Cyberchase.

Content Recall

About two-thirds of the children could identify an episode, 38% could identify the problem that was posed in the Cyberchase episode, and 29% were able to accurately identify how the heroes solved the problem. Students' recall of episode plots seems substantial. We believe that this is consistent with the children's indication that the content was engaging with its focus on the characters and their ability to think of ways to solve problems. Children who were more engaged with Cyberchase were better able to identify the method of problem solving used by heroes in Cyberchase.

Cyberchase Field Evaluation, Spring 2002

INTRODUCTION

Cyberchase is an animated math adventure Television Series broadcast on PBS, and has an accompanying online component http://pbskids.org/cyberchase/ which extends the reach of the program through various interactive activities. ROCKMAN *ET AL* undertook the evaluation of the Cyberchase Television Programs and the Cyberchase Website to explore its appeal and value to the target audience of 3rd and 4th graders.

Cyberchase is "designed to help millions of children around the world develop and sustain enthusiasm for mathematics and help increase their knowledge and skills." The project's overall goals are to:

- Foster a positive attitude towards mathematics and ensure children remain engaged with mathematics during their school years;
- Provide opportunities to develop skills in mathematics reasoning and problem solving;
- Demonstrate the usefulness of mathematical thinking; and,
- Motivate children to approach mathematics with enthusiasm, confidence, and competence.

The Cyberchase TV Show portrays three heroes, Jackie, Matt, and Inez, who use *brain-power* to thwart the dastardly villain, Hacker, in his mad quest to take over Cyberspace. Cyberchase Online provides children with the opportunity to play interactive games, solve challenging puzzles, and learn more about the characters. The focus of this study is on the Cyberchase TV Show and the Cyberchase Website.

Overview of the Study

ROCKMAN *ET AL* gathered information from 887 children in the 3rd and 4th grades in suburban Portland (Oregon), Chicago, and the metropolitan Boston area. The regional areas were selected to:

- Obtain national representation;
- Take advantage of sites with a five-day-a-week or greater broadcast schedule; and,
- Obtain a range of demographic characteristics among our sample.

ROCKMAN *ET AL* recruited specific sub-populations of African-American, Asian-American, Caucasian, and Hispanic students for this study. We assessed how often children frequent and how much they enjoy Cyberchase, and how their reactions differed across grade, gender, ethnicity, and degree of engagement (how often they watched Cyberchase). Researchers also interviewed children while they were online with the live Cyberchase Website.

METHODOLOGY

While some of the students participating in our study may have been viewing Cyberchase since its initial broadcast in January of 2002, we focused our efforts on a briefer viewing period of three weeks in May 2002. ROCKMAN *ET AL* designed and administered an age-appropriate survey in 3rd and 4th grade classrooms, and conducted interviews with a subset of 154 children who completed the survey. We attempted to balance the surveyed and interviewed samples across grade and gender, and selected participants for interviews based on their familiarity with Cyberchase. The participating children were at the end of their 3rd and 4th grade experience, and are the core Cyberchase target audience.

We collected data from a range of students in three ethnically diverse metropolitan areas in low socioeconomic status (SES) neighborhoods. All children recruited for the study were encouraged to view Cyberchase and explore its Website. We provided them with promotional materials and scheduling information. Children in half of the classrooms were given videotaped copies of four programs in addition to the promotional materials and scheduling information. The four selected episodes on videotapes were among those scheduled for broadcast during the study period. We collected general demographic data about the children from their teachers at the outset of the study. The entire sample was asked to complete a survey after the viewing period was complete.

While participants were recruited through schools and data were collected at school sites, researchers, not teachers, were responsible for interviews and survey administration and children did not view the programs in school, only at home. This was a naturalistic study and it was the children's choice to watch it or not—students were not required to watch the program, engage the website, or to participate in the study. Each participating child received a Cyberchase pencil and a postcard with local broadcast schedules on it. The children who were interviewed also received a Cyberchase mousepad after the interview was completed.

Research Areas

The research design and instruments for this study were developed in collaboration with the Cyberchase content and production groups. The survey and interview were designed to explore the following issues:

- Program enjoyment and appeal;
- Attitudes about doing math and self-confidence about mathematical problem solving;
- Website use patterns;
- Mathematical problem solving; and,
- Content recall.

Sample

The children participating in this study were drawn from 43 classrooms in 10 schools, and divided among suburban Portland, OR (26%), Chicago (42%), and the Metropolitan Boston Area (32%); see Table 1. The sample was balanced by gender (53% girls, 47% boys) and grade (54% 3rd, 46% 4th), and over-represented traditionally underserved minorities (37% African-Americans, 33% Hispanic, 15% Caucasian, 10% Asian-American, and 5% Other). Given the convenience sampling strategy, it is difficult to generalize to the entire population of children in the U.S., therefore, the findings by ethnicity should be interpreted with caution. Unless specifically noted, the sample includes all children surveyed.

Table 1: Sample's Geographic Distribution

Location	Grade	Classrooms	Schools	Students	Surveys	Interviews
Portland (26%)	3rd 4th	7 classes 7 classes	3 schools	229	229	41
Chicago (42%)	3rd 4th	8 classes 8 classes	3 schools	372	372	62
Boston (32%)	3rd	7 classes	4 schools	286	286	51

	4th	6 classes				
Total		**43 classes**	**10 schools**	**887**	**887**	**154**

Degrees of Engagement

To differentiate among those who watched Cyberchase occasionally or with greater frequency, we asked the study participants to rate their viewing patterns of Cyberchase (how often did they watch?). From this data, we divided the children into three roughly equivalent engagement groups: Low (32%), Medium (38%) and High (30%) levels of viewing. Throughout this report, we will refer to the degrees of engagement as low, medium and high.

Table 2: Sample's Description of Engagement Groups by Grade and by Gender[1]

Overall (n=864)		**Low** (32%)	**Medium** (38%)	**High** (30%)
3rd Grade	Girls (n=252)	68	99	85
	Boys (n=213)	65	82	66
4th Grade	Girls (n=208)	74	80	54
	Boys (n=191)	70	67	54
Total		277	328	259

Instruments

ROCKMAN *ET AL* designed and administered a paper survey to the entire sample (n=887), and conducted interviews with a subset of the children (balanced across grade and gender, and selected based on their familiarity with Cyberchase, n=154). Evaluators sought to select children of all levels of engagement, based on their answers to how often they watched Cyberchase and how often they visited Cyberchase Online. The survey asked children questions specific to the enjoyment and appeal of the program, attitudes about doing math, self-confidence in mathematical problem solving, as well as their Internet use. Interviews focused on obtaining information about Internet use, mathematical problem-solving, and content recall.

[1] The sample size varies in this case since there was not a clear identification of gender for each child.

Survey

The 30-minute survey asked children to answer true/false, multiple-choice, open-ended, and character enjoyment questions for Cyberchase. Some of the questions had been administered to other groups of children early in the broadcast year. [Phase I of the Cyberchase evaluation was conducted with 465 children in the fall of 2001, and relied on pre- and posttest surveys and children watching five episodes of Cyberchase in a school setting under the supervision of their teacher. This is in contrast to the naturalistic study conducted in this second phase of the evaluation.]

Interviews

Researchers conducted 30-minute interviews with 77 pairs of children (ideally one boy and one girl in each pair), in front of a live connection to the Cyberchase Website. The children were relatively balanced by grade (54% 3rd, 46% 4th), gender (51% girls, 49% boys), ethnic diversity (33% African-American, 31% Hispanic, 11% Asian-American, 19% Caucasian, and 6% Other), and degree of engagement (26% low, 37% medium, 37% high).

Based on available time, most of the interviewees (111) engaged in a specific problem-solving task on the Website during the interview. In order to cover as much material as possible and complete the task during the interview period, we rotated questions. Consequently, not every child participated in each portion of the interview. Evaluators took notes and audio-recorded interviews; each of the 154 interview tapes was reviewed and coded for content.

Measures for Attitude and Self-Confidence

Children's attitudes toward mathematics were measured by their answers to six items on the survey. Their self-confidence in solving mathematics problems was measured by their responses to an additional six items on the survey. Items were scored on a five-point scale. Groups of items according to attitude and self-confidence were shown to be reliable in our earlier study. Reliability was confirmed in this study. [The reliability index for Attitude about Math (α = .74), and the one for Self-Confidence about Problem Solving (α = .57).]

Program Enjoyment and Appeal

The survey also included questions about enjoyment and appeal of the Cyberchase TV Show and individual characters. The survey asked the children to rate their enjoyment of each of the characters, and the interview asked children to identify their favorite character.

Website Use and Mathematical Problem Solving

The survey asked the children about their Website use patterns. We supplemented these questions with a 10-12 minute portion of the interview devoted to watching the children interact with a specific online activity. Interviewers tracked the duration of the children's interactions, and their actions during the online activity.

Content Recall

During the interview, we also asked children to recall a specific episode of Cyberchase, and to talk about it. They were asked to describe what happened in the Show, identify the problem-solving task that the characters had to face, and how the characters solved the problem. We analyzed each of the five most commonly recalled episodes individually, to assure that the children's responses were applied to that episode.

Evaluation Findings

The data collected from target-age children identify Cyberchase as very appealing; it engages children in mathematical problem solving. The viewers and web-users find the characters appealing as models. Hispanic children, a low-performing minority in math and science assessments, are particularly enthusiastic about Cyberchase and report high self-confidence in solving mathematics problems. The Website has high appeal and strong "stickiness," keeping children engaged for long periods of time.

An examination of the degree of engagement groups by location, grade, gender and ethnicity revealed some small differences. The children most engaged with the series were located in Chicago, likely a reflection of the strong Hispanic composition of the sample there, and the fact that Hispanics most enjoyed Cyberchase. Third graders were more engaged with Cyberchase than 4th graders, confirming other findings in this study. There was no difference in degree of engagement by gender. African-American and Hispanic children were the most engaged with Cyberchase.

The more children watched Cyberchase the more enthusiastic they were about the television series and the website and the more they perceived the benefits from their interactions with them.

Given that we involved children who indicated that they already knew about Cyberchase and were in locations that had multiple broadcasts and high viewership, we found no differences in outcomes based on whether or not children had received a videotape of the Cyberchase episodes at the outset of the study. For the most part, they knew about it beforehand, although some children never engaged with Cyberchase.

To provide a context for the findings about Cyberchase, evaluators collected information about children's familiarity with PBS, their general television viewing habits and Internet use patterns.

Viewing Cyberchase

Most of the children in this study (86%) reported watching PBS (64% of the low engagement children, 96% medium, 97% high). Nearly three-quarters of the children listed Cyberchase as among their favorite programs (46% low, 78% medium, 89% high), and 77% of the children reported watching Cyberchase when they took the survey. This level of viewership may be, in part, a consequence of the research project's distribution of

promotional materials and may not reflect the viewing patterns of all children at a regional or national level.

Children who watch Cyberchase, commented that they do so because:

- "It's fun to watch." (42%)
- "I enjoy learning math." (23%)
- "It's educational/not like other cartoons." (12%)
- "I need help with math." (11%)

The most common reasons the children like the program include the Show's "math focus" (35%) and the characters' "success with problem solving" (22%).

Only 8% of the sample reported reasons for not watching Cyberchase:

- "Cannot watch at scheduled time" (36%)
- "Don't like Cyberchase" (28%)
- Find Cyberchase "boring" (10%)

Other popular programs among the children we surveyed include Arthur (62%) and Zoom (32%). Nearly two-thirds of the children watched Cyberchase "every day" (30%) or "some days" (29%), and about one-quarter (24%) of the children "never" watched the program. Over the course of the study, there was a statistically significant gain in viewing frequency.

Program Enjoyment and Appeal

Enjoying Cyberchase is a necessary condition for sustained viewing and helps establish the conditions for learning ideas from the material. Overall, the children report that they enjoy watching Cyberchase on TV and Cyberchase "For Real" segments. They also report enjoying the characters on the Show.

The Cyberchase TV Show

All the children enjoyed both the Cyberchase animated segments and the "For Real" segments. The Show was especially appealing to the Hispanic audience members. The children rated their enjoyment of both the Cyberchase TV Show and the "For Real" segments on a five-point scale (1=*Not at all* and 5=*A lot*). In addition to reporting the average score for these questions, we have converted the scores to a percentage appeal rating (actual score as a percentage of the maximum score of five).

- Viewers enjoyed both the animated portion of the Show (4.1, 82% appeal rating) and the "For Real" segments (3.9, 78%).

- The more children viewed Cyberchase, the more they enjoyed both the animated portion of the show (2.7, 54% appeal rating for low engagement viewers; 4.6, 92% medium; and 5.0, 100% high). The "For Real" segments also received high ratings (3.9, 78% overall; 2.6, 52% appeal rating for low engagement; 4.2, 84% medium, and 4.7, 94% high).
- Girls enjoyed the animated segments significantly more than boys (4.3, 86% appeal rating vs. 3.9, 78% appeal rating) and also enjoyed the "For Real" segments more (4.0 , 80% appeal rating vs. 3.8 , 76% appeal rating).
- While both are within the target audience of Cyberchase, 3rd graders enjoyed the animated portion more than 4th graders (4.3, 86% appeal rating vs. 4.0, 80% appeal rating) and they enjoyed the "For Real" segments more as well (4.0 , 80% appeal rating vs. 3.8 , 76% appeal rating).
- Cyberchase is reaching the Hispanic audience with appealing programming. Hispanics in the sample enjoyed the TV Show more than Caucasians (4.4, 88% appeal rating vs. 3.7, 74% appeal rating). Hispanics in the sample enjoyed the "For Real" segments more than African-Americans (4.3 , 86% appeal rating vs. 3.8, 76% appeal rating), and more than Asian-Americans (3.4 , 68% appeal rating) and Caucasians (3.6, 72% appeal rating).

In this second study, the children gave Cyberchase an overall 4.1 score, equivalent to an 82% appeal rating. In our first Cyberchase study, the children gave Cyberchase an overall 4.6 score, equivalent to a 93% appeal rating. This higher overall enjoyment rating may be a result of the design of the initial study, in which teachers showed five episodes of Cyberchase in class, and only children who watched all five episodes were included in the analysis. Classroom viewing may have been perceived as more enjoyable than other classroom activities, in contrast to this second study which relied on children's modestly encouraged viewing and visiting habits.

Cyberchase Characters

For reference throughout this section, Table 3 serves as a key to the individual characters. The characters are listed here in the order they were presented on the survey. The "heroes" are Motherboard, Matt, Jackie, Inez and Digit. The "bad guys" are Hacker, Delete and Buzz. The "For Real" characters are Harry and Bianca. We asked children to rate how much they enjoyed each of the Cyberchase characters on a five-point scale.

Table 3: Key to Cyberchase Characters

Hacker

Delete

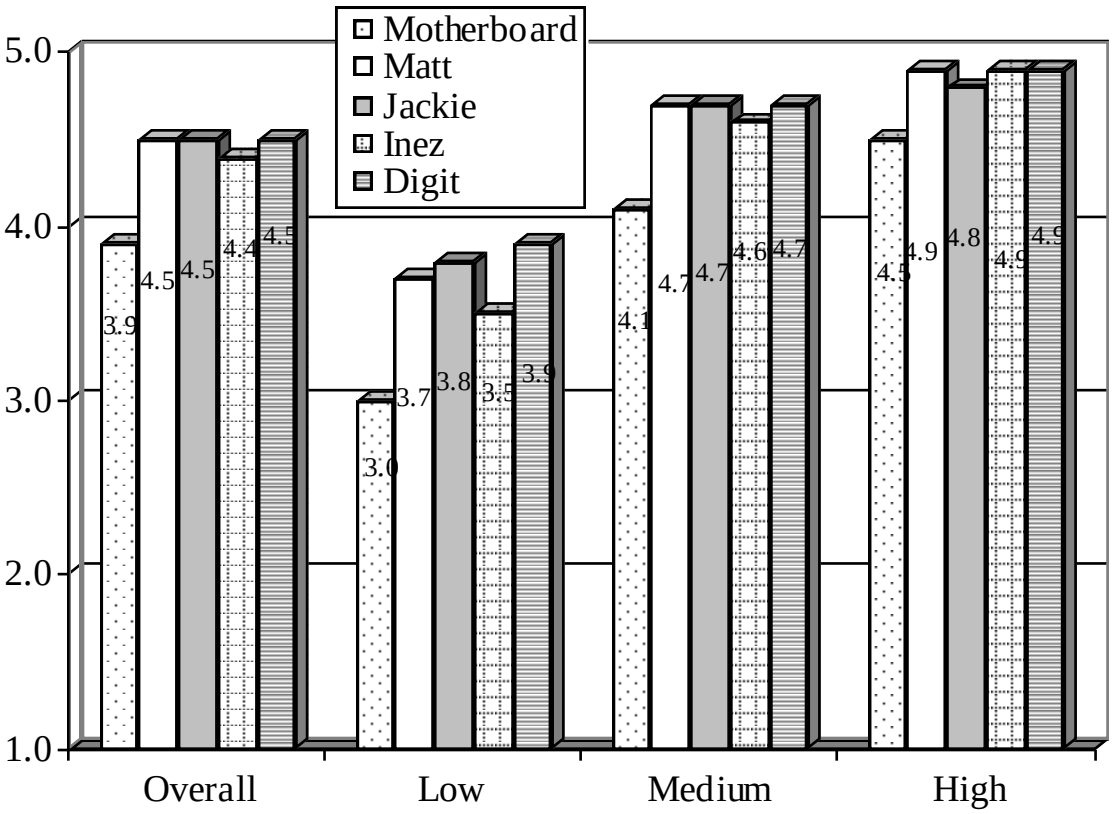
Buzz

The most popular characters among all the children were "the heroes" Jackie (4.5 score, 90% appeal rating), Matt (4.5, 90%), and Digit (4.5, 90%); Inez (4.4, 88%) followed closely behind. The least popular characters among all the children were the "bad guys": Hacker (3.0 score, 60% appeal rating), Buzz (3.3, 66%) and Delete (3.4, 68%). Among the children completing the survey, those who viewed most frequently (medium and high engagement) enjoyed all the characters more than those who were less engaged (low). Figure 1 provides details on the Cyberchase hero's popularity. All the characters were more popular with those children who were more engaged with Cyberchase (medium or high) than those who were less engaged (low).

Children who were interviewed also identified their one, most-favorite character by name, to confirm the data collected on character popularity. They favored Jackie (29%) and Matt (26%) because they are "smart" (22%), "funny" (18%), and they "solve problems" (16%). The characters liked the least are Hacker (61%) and Buzz (14%). Children didn't like them because they "play the bad guy" (51%) and are "mean, evil, and bad" (35%).

The children we interviewed indicated that they would like to see more of Motherboard (26%), Digit (25%), and Jackie (18%). Reasons for wanting to see more of these three characters are: they are "part of the team, a team player" (28%), they "do not see (them) often" (17%), and they are "funny characters" (17%).

Figure 1: Differences in Children's Enjoyment of Cyberchase Heroes By Degree of Engagement



We found significant differences by grade, gender, ethnicity, and degree of engagement in the popularity of individual characters. Table 4 summarizes the differences in character popularity by grade.

Table 4: Differences in Character Popularity by Grade

No Difference	3rd graders enjoyed more than 4th	4th graders enjoyed more than 3rd
Hacker Digit Delete Buzz	Motherboard Matt Jackie Inez Harry Bianca	No differences

In our survey, the "bad guys" (Hacker, Buzz, and Delete), and the robotic "hero" bird (Digit) were equally popular among 3rd and 4th graders. Third graders liked the "heroes" (Motherboard, Matt, Jackie and Inez, but not Digit) and the "For Real" characters (Harry and Bianca) more than 4th graders. Fourth graders did not enjoy any characters more than 3rd graders. Table 5 summarizes the differences in character popularity by gender.

Table 5: Differences in Character Popularity by Gender

No Difference	Boys enjoyed more than Girls	Girls enjoyed more than Boys
Matt Digit Delete Buzz Harry (For Real)	Hacker	Motherboard Jackie Inez Bianca (For Real)

Boys and girls did not differ on their popularity ratings for the minor "bad guys" (Buzz and Delete), male "heroes" (Matt and Digit), or the male "For Real" character (Harry). There were no differences in popularity by gender for all the male characters except Hacker. These characters appeal equally to boys and girls. Hacker, however, was more popular with boys than with girls. Girls rated all the female characters (Motherboard, Jackie, Inez and Bianca) more positively than boys did. Table 6 describes the popularity of the Cyberchase characters by ethnic group.

Table 6: Differences in Character Popularity by Ethnicity

African-Am. enjoyed more than Asian-Am.	**Caucasian enjoyed more than Asian-Am.**	**Hispanic enjoyed more than Asian-Am.**
Motherboard Matt Jackie Inez Digit Harry Bianca	Hacker Harry	Motherboard Matt Jackie Inez Hacker Digit Harry Bianca
African-Am. enjoyed more than Caucasian	**Hispanic enjoyed more than African-Am.**	**Hispanic enjoyed more than Caucasian**
Motherboard Matt Jackie Inez Digit Bianca	Hacker Delete Buzz Harry	Motherboard Matt Jackie Inez Digit Harry Bianca

There was great variety of character popularity across ethnicities. For example, Caucasian children from the sample enjoyed characters Hacker and Harry more than Asian-American children. Additionally, Hispanic children found characters Hacker, Delete, Buzz, and Harry more enjoyable than African-American children. In general, African-American and Hispanic children enjoyed most of the characters more than other ethnic groups. Among African-American children, Jackie (an African-American), Digit (a robotic bird), and Matt (a Caucasian boy) were the most, and equally so.

There is no Asian-American character on Cyberchase, however Asian-American children—as well as Caucasian children—identify Digit, Matt, and Jackie as the most popular. Among the Hispanic children, Inez (an Hispanic girl, 4.6), Digit (4.2) and Matt (4.1) were the most popular. The strong Hispanic character appears to capture the interest of Hispanic children, and appeals to the others, as well.

Children who viewed most often saw Motherboard as the most popular character, and the more regular viewers seemed to enjoy most of the characters in the programs.

Table 7: Differences in Character Popularity by Degree of Engagement

High enjoyed more than Medium enjoyed more than Low	Medium and High enjoyed more than Low
Motherboard	Matt Jackie Inez Hacker Digit Delete Buzz Harry Bianca

In summary, children enjoyed both the Cyberchase TV Show and the "For Real" segments. There was a small difference in popularity of the characters by grade, gender, ethnicity, and a moderate difference by degree of engagement indicating that the program appeals to a diverse audience.

We found that:

- Children who watched Cyberchase frequently enjoyed the animated portion of Cyberchase Show very much (5.0, 100% appeal rating). Children who watched Cyberchase frequently enjoyed the "For Real" portion of the Cyberchase programs very much (4.7, 94% appeal rating).
- 3rd graders enjoyed Motherboard, Matt, Jackie, Inez, Harry, and Bianca more than 4th graders.
- Girls enjoyed Motherboard, Jackie, Inez, and Bianca more than boys.
- Boys enjoyed Hacker more than girls.
- African-American and Hispanic children enjoyed most of the characters more than other ethnic groups.
- Children who were most engaged enjoyed Cyberchase and Cyberchase "For Real" the most.

Among the comments we heard about the characters and the Television Show are those below:

When Harry in the real world does weird things like play with dolls, I like that. Tory G. 3rd grade

I enjoy going to the Cyberchase website with my brother after school. Bianca S. 3rd grade

I like Matt. We have something in common—sometimes I think up ideas and sometimes I let other people think them up on their own. Ahsan D. 3rd grade

I like Inez because she knows a lot about math. Latara W. 3rd grade

I like Jackie's hair, clothes, and shoes. Brittany M. 3rd grade

I like Dr. Marbles because he is creative. Christopher 3rd grade

I like it (Cyberchase TV Show) because it shows you math stuff. Salvador 3rd grade

I would like to see Hacker, Buzz, and Delete less because they are the bad guys. Hamzah F. 3rd grade

It's interesting; the kids have to solve mysteries. Mariam S. 4th grade

It (Cyberchase TV Show) helps you with math and problem solving and it's fun. Moseline F. 4th grade

I like Jackie and Inez…they're always funny and smart. Tiffany H. 4th grade

I like how they all work together to defeat Hacker. Sadiya 4th grade

I like how the kids keep trying until they reach their goal. Dionne. 4th grade

Jackie is my favorite character because she figures out problems her own way. Sabrina 4th grade

I would like to see more of Digit because he makes people laugh and helps solve problems. Jesuid A. 4th grade

Attitude and Self-Confidence

The goals of Cyberchase include fostering a positive attitude toward mathematics and motivating children to approach mathematics with enthusiasm, confidence and competence. Our findings from this second study indicate that Cyberchase is making great strides toward accomplishing these goals. Children's attitudes about mathematics are quite positive and they have a high self-confidence about their abilities to solve mathematics problems. They seem to enjoy math problems and the more they engaged with Cyberchase, the more positive their attitude and their self-confidence.

In our survey section on attitude (4.2 mean), we found that children:

- Feel that math is useful to people (4.5)
- Feel comfortable figuring things out (e.g. puzzles, riddles, mazes, etc) (4.4)
- Like figuring things out (e.g. puzzles, riddles, mazes, etc) (4.4)
- Like math (4.3)

- Have "some" fun when they are doing math (4.2)
- Feel good about trying to solve hard math problems (3.6)

In our survey section on self-confidence (4.3 mean), we found that children:

- Feel very comfortable solving an easy math problem on their own (4.6)
- Feel very comfortable doing a crossword puzzle (4.6)
- Feel comfortable solving an easy math problem with their friends (4.4)
- Feel comfortable recognizing a repeating color pattern (4.3)
- Feel comfortable making an estimate of how long it will take to read a book (4.0)
- Think math is easy (3.9)

Attitude did vary a by grade, gender, and ethnicity. Attitude varied more by degree of engagement. The more children engaged with Cyberchase, the more positive their attitude about mathematics (low < medium < high). Third graders had a more positive attitude than 4th graders, and girls had a more positive attitude than boys. Hispanic children had a more positive attitude about mathematics than Caucasian children.

Self-confidence did vary by grade, gender, and ethnicity. Self-confidence varied more by degree of engagement (low < medium < high). The more children engaged with Cyberchase, the more positive their self-confidence about problem solving. We found that 3rd graders have more self-confidence than 4th graders, and girls have more self-confidence than boys in solving mathematical problems. Hispanic children in our sample are more self-confident about mathematical problem solving than are Caucasian children.

While the differences on attitude and self-confidence by grade, gender, and ethnicity are statistically significant, the absolute differences are small. The differences on attitude and self-confidence by degree of engagement are moderate. The direction of the results are consistent with the tendency of decreasing interest in, and self-confidence about mathematics that occurs across genders in late elementary school. Girls have a more positive attitude about math and are more self-confident in problem solving than boys. During middle childhood, girls develop mathematical and literacy skills more quickly than boys, and it is not until middle school that the boys outperform girls. Also during middle childhood, boys are very concerned with their perceived image by peers, and they may be less willing to admit that an "educational" series helped them with anything. Children who were most engaged with Cyberchase had the most positive attitude, and the most self-confidence in problem solving.

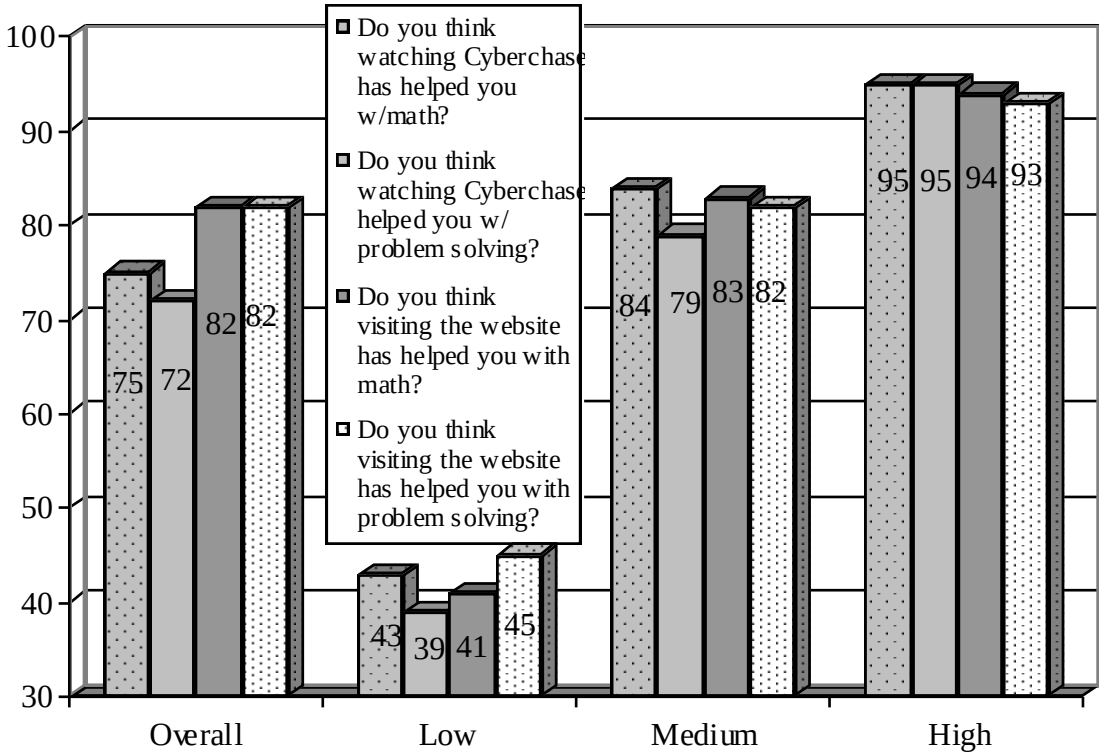
That the differences were in the predicted direction but were very small is an encouraging indicator that Cyberchase is making substantial progress towards its goal of ensuring that

"children remain engaged with mathematics during their school years." It is too early in their school career to know whether they will continue to possess the interest and enthusiasm we see in conjunction with Cyberchase, but we do see an indication that the historical pattern of diminished interest is not in evidence here.

Influence of Interacting with Cyberchase

Children were asked about the influence of the television programs and the Website on their math skills and problem solving. Among all the children, most feel that watching Cyberchase has helped them with math (75%) and with problem solving (72%). Among children who watch the TV Show and visit the Website frequentlyhad high engagement with Cyberchase, nearly all feel that watching Cyberchase has helped them with math (95%) and problem solving (95%). Most of the children who watch the TV Show and visit the Website frequently feel that visiting the Website has helped them with math (96%) and problem solving (92%). The more they watched engaged with Cyberchase on TV, and the more they visited the Cyberchase Website, the more they perceived an increase in math and problem solving skills (see Figure 2).

Figure 2: Differences in Perceived Improvement in Math and Problem Solving By Degree of Engagement



Summary of Findings for Attitude and Self-Confidence

Children in our study had a positive attitude about mathematics and self-confidence about problem solving. The more children engaged with Cyberchase, the more positive their attitude about mathematics. Differences in attitude and self-confidence by grade, gender, and ethnicity are statistically significant, but the absolute differences are small. Differences in attitude and self-confidence by degree of engagement are moderate. The findings are consistent with children's decreasing interest in and self-confidence about mathematics in late elementary school. This supports the belief that Cyberchase is slowing the slide toward lower interest and confidence in math. Among the comments we heard about the Television Show and Website are those below:

The Cyberchase TV Show gives you a better perspective on school. Caspar M. 3rd grade

I think the TV Show is for kids just starting math. Shalia 3rd grade

I like the Show because I can do division and math problems. Alexus 3rd grade

I'd like to see more of Jackie and Hacker. Shalamar 3rd grade

> *The Show helps with math and writing down problem solving. Armando S. 4th grade*

Website Use

We asked children about their use of the Cyberchase Website and the skills they learned from using it on both the survey and during the interview. Overall, about one-third (33%) of the children had visited the Cyberchase Website after watching the TV Show (17%^ low, 33% medium, 51% high). Of those interviewed, two thirds (67%) had visited the Cyberchase Website. This was consistent across grade and gender. Nearly two-thirds (65%) of the children interviewed learned about the Cyberchase Website from either their PBS station (54%) or PBS Website (11%). Boys in both 3rd and 4th grade also reported that their teachers directed them to the Cyberchase Website. Some girls (but no boys) were directed by a sibling. Children reported that they visited the Website because:

- It is "fun" (31%)
- They "enjoy playing games" (29%)

When the children visited the Website, nearly two-thirds (65%) of the children stay an hour or more. This is an overwhelming statistic, and attests to the creativity of the production team at WNET and the appeal of the Website content. "Stickiness," that is getting children to visit a website and be sufficiently engaged to sustain a visit over a long period of time, is a good measure of the quality and appeal of the materials on that site. Comparisons with other TV show related websites indicate that the Cyberchase Website is extraordinarily successful.

Children who do not visit the Website say that is because they do not have Internet access (55%). This is a reflection of the larger digital divide, where less access to the Internet can be found among minority households and children from lower SES settings. Much of our sample was derived from such settings.

Three-quarters (76%) of the children who visit Cyberchase on the web do not need help doing so, and boys were less likely to admit to needing help. Girls listed a variety of recently accessed activities:

- *Today's Stuff*
- *Disguise Combos*
- *Crack Hacker's Safe*
- *Can You Fill It?*

- *Logic Zoo*
- *Thirteen Ways to One Half*
- *eCards.*

Perhaps girls pay more attention to the names of the activities and are able to produce them spontaneously, or perhaps boys are truly accessing fewer numbers of activities.

Children said they like the Cyberchase Website because of its:

- Games (47%)
- Math focus (18%)
- Fun (16%)
- Learning (8%)

Eight out of ten children (82%) in our survey who visited the Cyberchase Website felt that it helped them with their math skills. Among the reasons they give are that they "learn new math and skills" (23%), it "makes math fun" (21%), and they "needed help with math" (13%). The more children viewed Cyberchase, the more they feel that it helped them with their math skills (41% of low engagement children, 83% of medium, 94% of high). In addition, eight out of ten (82%) feel that it has helped them with their problem solving skills (45% low, 82% medium, 93% high). Children say that Cyberchase: "makes problem solving fun" (21%) and "makes it easy to understand" (20%). Girls also say that it helps them in "learning new problem solving skills."

Among the other findings about the Cyberchase Website:

- Children who view Cyberchase frequently (both high and medium groups) found the Website to be more helpful with problem solving than those who view less frequently.
- Children who are more engaged with Cyberchase visit the website more often and stay longer (low < medium < high).
- 3rd graders and girls found the Website to be more helpful with problem solving than 4th graders and boys.
- Hispanic children found the Website to be more helpful with math and problem solving than Caucasians.

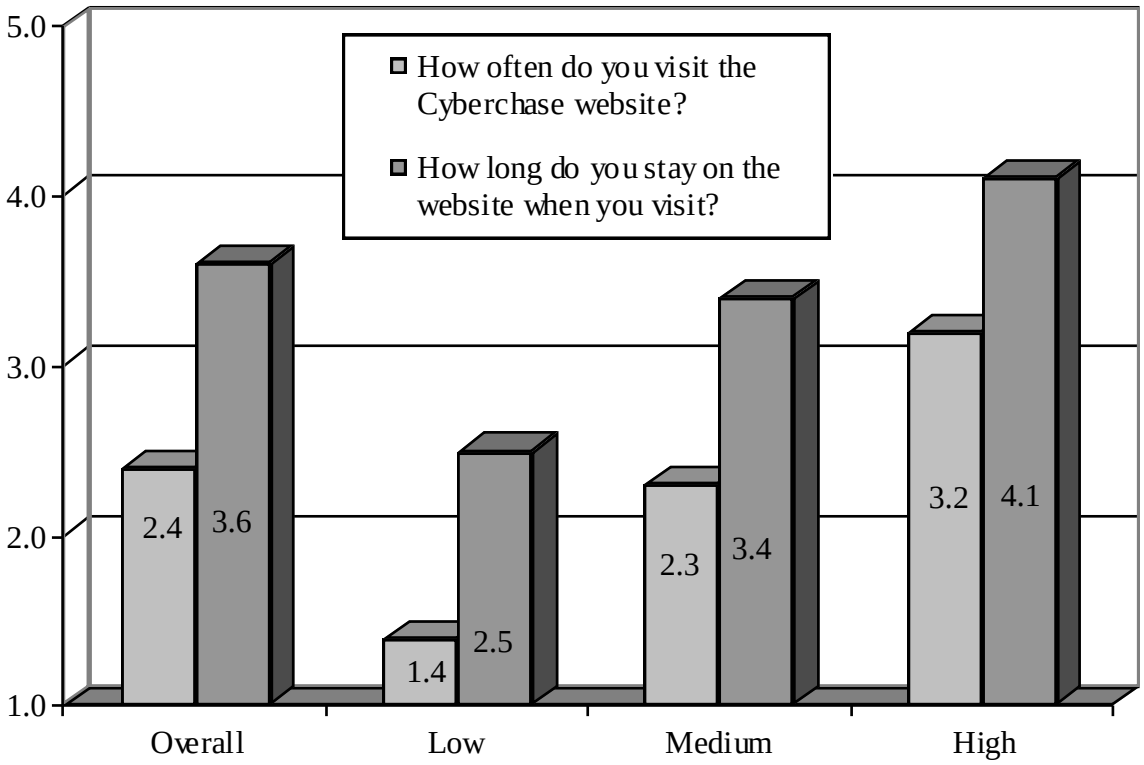
We found that children who view Cyberchase more regularly believe the Website to be more helpful with both math and problem solving. This suggests that the more exposure all children have (regardless of grade, gender, or ethnicity) to Cyberchase, the more helpful it is in transferring math skills and problem solving skills.

Website Surfing Patterns

While both third and fourth graders, as well as boys and girls, had similar Website surfing patterns (defined as duration and frequency of Website use), there were differences in surfing patterns by ethnicity. Hispanic children visited the Cyberchase Website more frequently than Caucasian children, and stayed longer on the site than either Asian or Caucasian children. African-American children visited the Cyberchase Website more often than Caucasian children, and stayed longer than Asian-American children.

Children who watched Cyberchase on TV frequently stayed longer on the Website than children who viewed less frequently (medium or low engagement). Figure 3 provides a summary of the differences in Website surfing patterns by degree of engagement.

Figure 3: Differences in Website Surfing Patterns by Degree of Engagement



Summary of Website Findings

When children, regardless of grade, gender, or ethnicity, visited the Website, nearly two-thirds (65%) stay online for an hour or more. This indicates that the Website has a very impressive pull, and keeps the children engaged and enthusiastic for a long period of time. Regardless of grade, gender, or ethnicity, the more exposure all children have to Cyberchase, the more helpful it is to them with math and problem solving skills. Third (3rd) graders, girls, and Hispanic children found the Website most helpful. This is consistent with the enjoyment and appeal findings. The more the children enjoyed Cyberchase and characters, the more helpful it was. The more children viewed Cyberchase, the more they visited the Website. This makes sense as children who are more engaged are likely to spend more time with Cyberchase, and thus are more likely to feel that they have been helped with both math and problem solving skills.

Some of the comments we heard are listed below:

The fractions games are hard, but I like them. Chris H. 3rd grade

I help my sister and my cousins go on websites. Cory J. 3rd grade

I used to need help going on to the Cyberchase website. Not anymore. Jermaine 3rd grade

I help my friends go to the web at my house. Jamar 3rd grade

I saw the website from watching the TV program. Cecilia K. 3rd grade

They showed the Cyberchase website on TV or the Time for Kids magazine… Aman K. 4th grade

I help my brother go to the web. Keegan M. 4th grade

I found the Cyberchase website by watching the TV Shows. Jefferson L. 4th grade

The games on the Cyberchase website are not that hard. They're good for younger kids too. Joyce 4th grade

Mathematical Problem-Solving

To assess the sample's problem-solving skills, the children we interviewed were asked to play a specific game on the Cyberchase Website: *Thirteen Ways of Looking at One-Half*. The children's problem-solving skills were tracked throughout out four possible phases of the increasingly more difficult online problem solving activity. Although the intention was to have each of the children selected for an interview participate in the online problem solving activity, in reality, this was not the case. Some of the children were asked to focus on other parts of the interview, to better gain a broad knowledge base from the interviews; others spent more time on the game. Time constraints in our school visits and data capture difficulties made it difficult to collect sufficient information to fully explore this goal of the study. We will, nevertheless, report on some of our findings.

There were 111 children who started the online problem solving activity. Of those children who started Phase I of the online problem solving activity (*game introduction*), 55% of them continued through Phase II (*initial play*). Half of the initial group (50%) played Phase III (*systematic play*) and most of those (47%) persisted to Phase IV (*finding the hard ones*). See Table 8.

The goals of the problem solving component were to find out about what the user knows, thinks, and feels about solving problems that require some insight for their solution, using an engaging web-based Cyberchase game (*Thirteen Ways of Looking at One Half*) as the environment in which this is explored. Interviewers tried to assess:

- Their attitude, degree of optimism or pessimism about the prospects for success;
- Evidence for their understanding what the problem is;
- Evidence for their understanding what makes different patterns successful or not;
- Their flexibility in trying different approaches when the difficulty increases; and,
- The presence or absence of any method, plan, or strategy in response to the increasing difficulty of the game as it gets harder to find additional solutions.

We sought to make an effort to find out as much as possible about what the children know, think and feel as they play this game, without assisting them or influencing how long they persisted before giving up. Persistence in the face of difficulty is one of Cyberchase's 'lessons' and we did not want to level the responses of all participants by helping them along. Given the relatively small sample size (n=111) of children who even began the problem solving activity, it was difficult to conduct much statistical analysis to determine the relationship between engagement and success in problem solving.

Table 8: Persistence Of Interviewees Through Problem Solving Phases

Phase of Game		Number of Interviewees (%)
I.	Game Introduction	111 (100%)
II.	Initial Play	61 (55%)
III.	Systematic Play	55 (50%)
IV.	Finding the Hard Ones	52 (47%)

Phase I (Game Introduction)

The online problem solving game was introduced to the children:

- 71% of the participating children (n=79) paid attention to the introduction;
- 79% of the children (n=88) seemed interested in the game at the outset;
- 35% of the children (n=39) appeared to be able to operate the controls of the game;
- 25% of the children (n=28) appeared unsure what the game was about; and
- 4% of the children (n=4) seemed to know "a lot" about the goal of the game.

Phase II (Initial Play)

They began the game and had to engage the content materials:

- 34% of the children seemed to know what to do when they started the game.
- 55% of the children understood why their suggested patterns were accepted by the program.
- Children who were engaged with Cyberchase (medium or high) were also successful with Phase I. These children may have already practiced on this activity.
- 22% of the children tried the help button, but only one third of those (8%) did what the help suggested.
- 41% of the children responded to the error messages.
- 59% of the children were random rather than systematic (10%) in their attempts to complete patterns. This is consistent with their not being sure about how the game was supposed to be played.
- 49% of the children were interested in the activity.

Phase III (Systematic Play)

By the third phase of the game, once the easy patterns had been found, some of the children lost interest, gave up, or ran out of time. At this point, half the children of the original 111 were still engaged in the activity. One-third of the children (36%) who started the online problem solving activity saw the difficulty of the game as a "positive challenge" rather than a "negative burden" (11%). As the trial and error method became less successful, fewer children were looking for a pattern or method to follow, but 40% of the children seemed to understand why their choices were not accepted. This may indicate that the children were actively engaged and interested, even if they did not understand the point of the activity. Nearly one-quarter (22%) of the children playing the game seemed to stop and re-evaluate when their attempts were unsuccessful, and over one-third (34%) referred back to their list of "found patterns" in order to locate new ones. Only 5% of the children tried to change the existing patterns in any systematic way.

Phase IV (Finding the Hard Ones)

By the final phase of the game, nearly half the children (47%) who began the online problem solving activity were still engaged. Some of those were persistent (35%), and 12% were frustrated. Some children wavered (5%), but few gave up (3%). By the conclusion, 11% of the children were forced to try other methodical tactics to finish the activity, but most of the attempts (28%) were random. The children seemed to end the game on a positive note, however, with relatively few children either frustrated, or wanting to stop.

As trial and error became less successful, only 11% of the children were looking for a new pattern or method to follow. The proposed "clue button" might help to keep the children

visiting the site more on track. Many (36%) of the children who started the online problem solving activity saw the difficulty of the game as a "positive challenge," which indicates that the children were actively engaged, enthusiastic, persistent, and interested in the Cyberchase Website, even if they did not understand the point of the activity.

Problem-solving efforts varied. Some children self-corrected when they were unsuccessful, and some reviewed the patterns that they had already found in order to find new patterns. It seems that the difficulty of this Cyberchase Website activity was about right. There were some children who are able to grasp the concept of the game, and others for whom it was too difficult. The children seemed to end the game on a positive note, however, with relatively few children either frustrated, or wanting to stop.

Following are some quotes from the interviewed children indicating that Cyberchase is a positive help to both math and problem solving.

> *Cyberchase teaches me new strategies to solve problems. Claire P. 4th grade*
>
> *Solving the math problems helps me get better grades. Kathleen A. 3rd grade*
>
> *The characters make problem-solving fun. Vincente M. 3rd grade*
>
> *The Show helps you solve problems in different ways. Malika 3rd grade*

Summary of Mathematical Problem Solving

It is not clear how many of the children we interviewed may have practiced this particular activity before the interview itself. When they started the Cyberchase online problem solving activity, most of the children seemed to understand why their patterns were accepted. By the third phase of the game, once the easy patterns had been found, some of the children lost interest or gave up, and others may have run out of time. At this point, half the children were still interested in the activity and by the final phase they were still engaged. Nearly one-third (27%) of the children were persistent at trying to find new patterns, 20% were positive and less than ten percent (7%) were frustrated.

Content Recall

During the interview, children were asked to recall a specific episode of Cyberchase. They were asked to briefly describe what happened in the Show, identify the problem-solving task that the characters had to face, and how they solved the problem. Each of the top five identified episodes was analyzed individually, to assure that their responses applied to that episode. Two-thirds (64%) of the children could recall an episode, and most of them (53% of

the interviewed children) recalled one of the four on the tape provided at the outset of the study to half the children: *Of All the Luck* (22%), *A Day at the Spa* (18%), *Codename Icky* (8%) or *Eureeka* (7%). Another 11% of the children recalled, *Cool It*, an episode that was not on the tape.

Since so many of the children recalled an episode that was provided on the videotape, we believe that children may have shared the tapes with students in other classrooms (since there were other episodes broadcast during the testing window). All of the children who were able to recall an episode were able to recount the basic plot/premise of the episode. Although there was not a statistically significant difference between degrees of engagement (measured by χ^2), the more engaged the children were with Cyberchase, the better their content recall ($r = .24$, $p \leq .05$).

Thirty-eight percent of the children (38%) who recalled an episode could identify the specific problem for the heroes to solve and more than one-quarter of the children (29%) who were able to recall an episode were able to correctly identify how the characters solved the problem. There was a statistically significant difference by degree of engagement in ability to recall plot (measured by χ^2, $p \leq .001$; low < medium, high). It is not clear how many times each child watched each episode, so that may be a confounding variable in this analysis.

Students' recall of episode plots seems substantial, especially in the recall of an episode's problem, and its solution in sufficient detail for us to identify the information as consistent. There was also a strong positive correlation between ability to identify the problem which the heroes had to solve, and the ability to identify the methodology with which they solved that problem ($r = .63$, $p \leq .001$). We believe that this is consistent with the children's portrayal of the content as engaging and the focus on the characters and their ability to think of ways to solve problems.

Summary of Content Recall

Two-thirds of the interviewed children were able to recall one of the top five most frequently recalled episodes. Thirty-eight percent of the children who recalled an episode could identify the specific problem for the heroes to solve, and twenty-nine percent of the children were able to correctly identify how the characters solved the problem. Children who were more engaged (medium and high) were better able to recall the problem solving methodology than those who were less engaged (low). Cyberchase seems to engage many of the children to such a degree that they were not only able to recall an episode, but some of them could recall the specific problem to solve, and also how the characters solved it. There was a positive correlation between degree of engagement and the problem to be

solved as well as ability to recall the specific methodology required to solve the episode specific problem.

SUMMARY OF FINDINGS, IMPLICATIONS, AND RECOMMENDATIONS

Cyberchase was very popular with 3rd and 4th grade children. The more they engaged with Cyberchase, the more they enjoyed it, and the more they reported that it helped them with both math and problem solving skills. Cyberchase is especially appealing to the 3rd graders, to girls, and to Hispanic children. Cyberchase is appealing to a diverse audience. The Cyberchase Website is particularly successful in getting children to interact for substantial periods of time. Hispanic children are more enthusiastic about Cyberchase, and report being influenced by it more than Caucasian children. The more children view Cyberchase, the more benefit they derive from it.

Enjoyment and Appeal

There is a strong relationship between viewing and enjoyment, and it is even stronger when frequent interactions with the Website are included.

Cyberchase has built an audience that is enjoying the program. The audience needs to be nurtured and their interests sustained over time. New programs will keep most of the viewers interested, as will new challenges on the Website.

The characters are appealing to the viewers and their diversity permits all children to identify with one or more of them. Efforts to further develop the characters will also pay off for many of the older viewers, as they can grow with more complex characterizations.

Attitude about Mathematics and Problem Solving

Children have a positive attitude about mathematics and math problem solving. The more children engaged with Cyberchase, the more positive their attitude about mathematics and their self-confidence in problem solving.

The audience for Cyberchase has a positive attitude toward mathematics and is self confident about math problem solving. Hispanic children are more positive about math and more self-confident about mathematical problem solving than Caucasian children. Educators need to be aware of the potential influence of Cyberchase for their students. If children can carry the positive attitudes and self-confidence with them from home to school, or if teachers can use selected programs in class, then students may be motivated

and engaged in mathematical problem solving and demonstrate improved performance in math assessments.

Website Use

When children, regardless of grade, gender, ethnicity, or degree of engagement, visited the Cyberchase Website, two-thirds stay online for an hour or more. The Website has a very strong pull, and keeps children engaged and enthusiastic for a long period of time.

With longer time on the Website, children have more opportunities to identify and practice math and problem solving skills and to become engaged with ideas about math. The chance to work with math problems and tasks on the Website can solidify the gains children make from viewing the TV programs. Teachers may find that assigning activities on the Cyberchase Website can be beneficial, too.

Mathematical Problem Solving

By the third phase of the game some of the children lost interest or gave up, and others may have run out of time. At this point, half the children were still interested in the activity and by the final phase they were still engaged. Nearly one-third of the children were persistent, and one-quarter were positive. Less than ten percent were frustrated.

Content Recall

Over one-third of the children who identified a Cyberchase episode could identify the problem that was posed, and nearly one-third were able to accurately identify how the heroes solved that problem. There was a strong positive correlation between degree of engagement and ability to recall the problem and to identify how the heroes solved the problem. The more children were engaged with Cyberchase, the more readily they could identify the problem solving methodology.

The strong recall of episodes and the problems and solutions contained in them suggests that the characters and ideas capture the imagination of the viewers and help them remember the problem solving strategies shown in the TV programs. It is likely that the learning impacts of the programs may show up in transfer tasks, where solutions demonstrated in the TV Shows and/or solidified on the Website are applied in novel circumstances.

RECOMMENDATIONS

Here are some recommendations, based on the findings of this study of Cyberchase. The following ideas are offered for consideration.

Develop existing characters and/or introduce more mature ones.
While capturing the attention of the target audience in general, Cyberchase is most appealing to younger viewers. It would have a greater chance to sustain the interest of the older group of viewers by having some of the appealing characters develop further and become more complex. If there are opportunities, as new programs are created, consider ways to develop and evolve the existing heroes to attract older children to Cyberchase and to strengthen the characters' popularity across age groups. Alternatively, a new, more sophisticated hero could be introduced without diminishing the effectiveness of the existing characters.

Introduce another male hero.
If a new character is to be introduced, consider making that a male. Currently, the TV Series and many of its characters are more appealing to girls than to boys. If possible, with additional programs to be produced over the coming years, add a more sophisticated male "good guy" character that learns from his mistakes and is persistent. Such a character would appeal to both older children and boys, and provide a role model with whom they can identify.

Broaden the appeal of Cyberchase with diverse characters.
Add more diverse characters, if even for a single Show, such as: more "hip" kids with various interests and special talents such as probability (game players), mp3 files, solving mysteries, a white girl, an artist, a musician, a ham radio operator, a child with special needs. Twenty-eight percent (28%) of all children "don't like Cyberchase", so they don't watch it. An additional 11% of all children find Cyberchase "boring", which is why they don't watch.

Continue to emphasize outreach for the Cyberchase Website.
A high percentage of children who visited the Website indicate that it helped them with math and problem-solving skills thus more children should be encouraged to participate. Sustaining existing strategies and expanding efforts, especially in print that reaches children and parents.

Reassess the help system for the Cyberchase Website.

The addition of a character voiced aural help system could involve children who have various learning styles. Such help could also provide more direct instruction, or self-directing cues from characters who would encourage more children to be successful (and thus revisit) the Cyberchase Website.

Increase the scope of the Website.

The Website could provide additional opportunities for boys to engage in games and activities that appeal to them. Games could contain multiple levels as a way to sustain attention and keep older kids on the Website. More activities for girls should incorporate opportunities to construct objects that may be solutions to math problems. In addition, web developers might:

- Include activities that children and/or parents can print out and take in the car (such as finding patterns, shapes, geometry in landscape while driving).
- Include games or activities that children can play interactively with other children (i.e. others who are logged into the system at that time) and/or
- Include games that children can print out to play with their peers at school, on the playground, or other places where they may not have Internet access.
- Include games and activities that are specifically intended to be solved with a more competent peer (i.e. parent, caregiver, older sibling).
- Include games and activities that appeal particularly to boys, and particularly to girls.

Increase broadcast schedules.

As more programs are produced and introduced into the PBS system, encourage stations to have multiple plays that include an after-supper slot. Many children who might enjoy Cyberchase are busy after school with activities and chores, but could view at dinner time or later.

Increase the graphic user interface quotient.

Perhaps the Cyberchase Website could include more direct instruction (i.e. a "clue button" that provides appropriate cues in the characters' voices) and could assist children in feeling more confident from the start.

Cyberchase Phase II
Field Evaluation Spring 2002
The Television Show and the Website

APPENDICES

Student Survey
Student Interview
Student Interview Tracking Sheet