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Formative Evaluation of *CYBERCHASE* *The Poddleville Case*

Report for
WNET

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INTRODUCTION

With support from the National Science Foundation, WNET is producing a new TV series for children. Titled *Cyberchase,* the animated series presents a team of kids using mathematics to overcome challenges in the course of their travel through cyberspace. This formative evaluation gathered feedback from third and fourth graders in response to a pilot episode, *The Poddleville Case*, which focused on pattern problem solving. The general goals for the research were

- To evaluate appeal of the program as a whole as well as specific program elements like the team of kids;
- To establish age appropriateness;
- To estimate motivational impact by looking at student interest in trying to solve similar pattern problems and interest in seeing another show in the series;
- To explore comprehension of the main plot events;
- To determine what viewers felt they learned;
- To assess changes in pattern solving ability;
- To examine children's understanding of pattern problems.

METHOD

Procedure

Third and fourth graders were recruited to view in classes at two sites: Milford, DE, Portland, OR. At the Delaware site, two third grade classes and one fourth grade class answered previewing questions about demographics and a three-item previewing pattern problem test. After viewing the show, the students answered the same pattern problem test and postviewing questions about their opinions of the show.

At the Oregon site, one third grade and one fourth grade class answered the same pre-viewing questions as Delaware and viewed the show. After viewing, students completed a postviewing questionnaire that focused on opinions and the generation of their own pattern problem. OR students did not complete the posttest that DE students did. Instead, 7 third graders and 10 fourth graders were interviewed individually about a pattern that they generated themselves, and a different 6 third graders and 6 fourth graders were interviewed individually about comprehension of the basic story elements in the pilot show.

Prior to viewing, researchers introduced the background story of the series as follows:

> I want to give you some background to the show. I want to introduce you to the characters before you watch the show. Please listen:

From the beginning of time, MOTHERBOARD has ruled the cyberworld. All has been peaceful until MOTHERBOARD's brilliant assistant, named HACKER, turned on her. With the help of his wacky henchmen, BUZZ and DELETE, HACKER planted a deadly computer virus in MOTHERBOARD. HACKER's goal was to take over the cyberworld.

And now, MOTHERBOARD is in serious trouble. The virus has drastically weakened her powers, and the entire future of cyberspace is in jeopardy. Desperate times call for desperate measures. Her only hope is to run an elaborate computer search of every being in every galaxy for the right combination of bravery, moxie and math skill. Three kids meet her needs: JACKIE, INEZ, and MATT.

Each is as different as night and day, but together they make an awesome team. Their mission is to defeat HACKER and restore MOTHERBOARD and her peaceful reign. Their only weapon is BRAIN POWER. MOTHERBOARD summons the team into cyberspace and the Cyberchase is on!

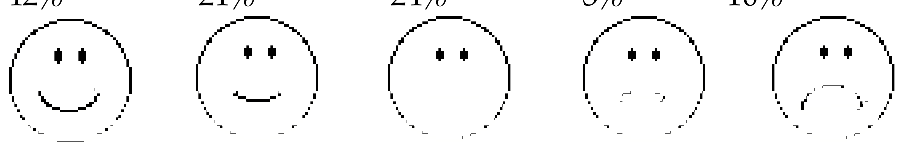
Sample

The sample of 114 students included 53% third graders and 47% fourth graders. There were 56% male respondents and 24% minority students in the total sample.

<u>Attitude toward math in school</u>. About 63% of the sample liked math in school, 24% were neutral, and 13% disliked math, as presented in the "face" scale below. Appeal of math in school was not independent of grade; third graders liked math more than fourth graders. No significant influence was found for gender, ethnicity or geography.

How much do you like or not like math in school?

ALL (N=113)	42%	21%	24%	3%	10%



3rd (n=59)	44%	22%	27%	5%	2%
4th (n=54)	39%	20%	20%	2%	19%

Data Analysis

Postviewing data for the two samples (DE; OR) are combined where appropriate. All percentages are rounded off to the nearest whole number, permitting some data tables to add up to more than 100%. Data were examined for statistically significant differences among grade, gender, geographical area, ethnic group as well as significant correlations with appeal of math in school and appeal of doing the previewing pattern problems. Any significant differences ($p < .05$) and correlations beyond a chance result are reported as "significant" in the results text sections that follow. In tables presenting qualitative data categories, the categories of highest frequency for sub-samples are bolded.

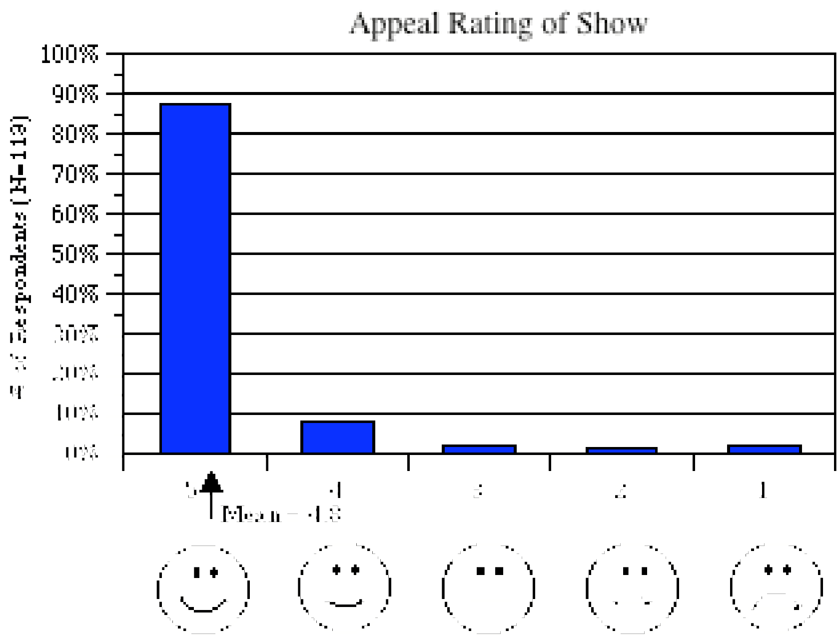
RESULTS: APPEAL

The Poddleville Case appealed to 96% of the viewers; 88% liked the show very much. The mean appeal rating was a very high 4.8 out of 5. Students' grade, gender, ethnic background and interest in math did not influence the appeal ratings. The more students liked doing the previewing pattern problems, the higher appeal ratings they gave the show.

When asked what they liked about the show, one-fifth of viewers reported that they liked the whole show. Smaller portions of the audience liked when the team figured out the egg-lock pattern (17%); liked the poddles, especially triangle #1 (12%); liked the patterns or math (11%) and liked the team of kids (7%). Because the show was so appealing, few viewers could identify what they did not like about the show. Small groups of children focused on not liking the bad guys (9%); the kids in jail (6%) and the stealing of the eggs (4%).

When asked to describe the personalities of the three kid characters, most viewers used "smart" and "funny" for Jackie, "cool" and "smart" for Matt and "smart" and "nice, helpful" for Inez.

Appeal of the Whole Show



After viewing the show, all but 5 of the 113 respondents were positive in their response about how much they liked the show, with 88% circling a "very happy" face and 8% circling a "sort of" happy face (see chart). Translating the face scale to numbers (5 to 1) yields an overall mean appeal rating of 4.8 out of 5. This mean rating is as high or higher than ratings obtained in formative evaluations of children's shows that are now being broadcast successfully. The appeal data were independent of all the demographic variables. Appeal of the show, however, was correlated positively with appeal of doing the pretest pattern problems (r = .32). The more students liked doing the previewing pattern problems, the more they liked the show.

What Viewers Liked and Did Not Like about the Show

The viewers were asked what they liked and did not like about the video. The tables that follow present the major categories of what viewers liked and did not like about the show, in the order of most frequent category to least frequent category for the whole sample.

The third graders liked most the egg lock solution (17%) and the poddles, including #1 (15%). Most fourth graders (26%) liked the whole show best as well as figuring out the egg lock (17%). Only categories obtaining at least 3% of respondents are listed in the table below, but individual viewers referred to little details reflecting an intensity of interest while viewing the program (e.g., I liked "when they go into cyberspace;" "two bad guys ran into each other;" "the little wocky tocky;" "Jackie dressed as an egg;" "when Jackie decided to eat cereal instead of an egg.").

Few viewers wrote about things that they did not like about the show because they "liked it all." Most of what was not liked was necessary to the dramatic telling of the case - the bad guys; the stealing of the eggs; and the kids in jail. Categories obtaining at least 3% of respondents are listed in the table on the next page.

What viewers liked about the video

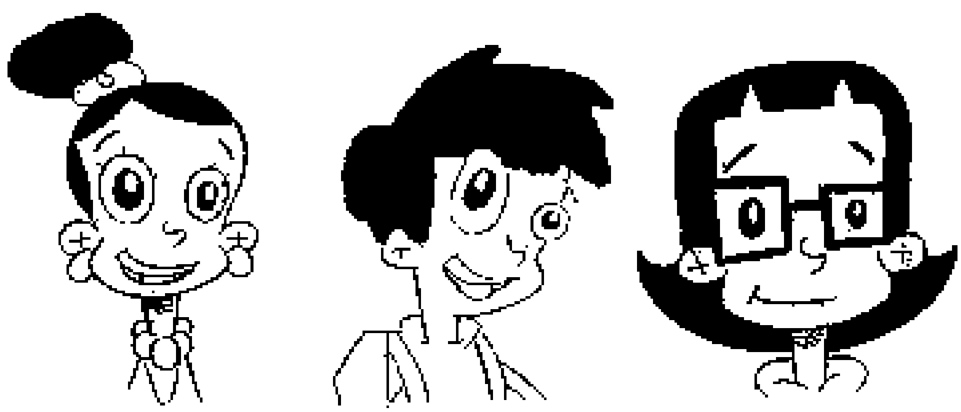
What was liked: example comments to demonstrate range, not quantity	**All N=114**	**% 3rd n=60**	**% 4th n=54**
Whole Show: Whole thing cuz it was neat. Funny. Had everything I liked. Every minute was good. Different. Perfect. Because it was about solving problems. Because it tells you a lot of math.	20%	12%	**26%**
When they figured out the egg pattern: When they got the code because it was the main thing. Because you had to do math equations. Because it was easy for me to get. Because it shows how smart kids can be. Because it was fun. Neat. Saving people.	17%	**17%**	**17%**
Poddles; #1 triangle: They look cool. They had long noses. He was cute and helped save potterville. He was nice and funny looking. He was thoughtful and nice. The aliens were cool.	12%	**15%**	9%
Patterns; math: The patterns because they were cool when they got them right. I liked solving the patterns. The beginning pattern was neat because they had to find the pattern for the code. Figuring out the patterns because of the hardness of it. You can do lots of math and patterns. It made me like math more. It has math work in it, that was neat.	11%	10%	11%
Characters, kids, team: They were really smart. Funny. Creative. Used their brain and that's important. Were a team.	7%	7%	7%
Final solution of putting #1 triangle in slot Where triangle #1 fit and wasn't an egg. Jackie used the little kid for the thing.	4%	5%	2%
Mystery, case The mystery was interesting. The case was exciting.	4%	3%	4%
In jail When Jackie was trying to get out of the basement. When strapped in the rope.	4%	5%	2%

What Viewers Did Not Like about the Show

What was not liked: example comments to demonstrate range, not quantity	**All N=114**	**% 3rd n=60**	**% 4th n=54**
Hacker and henchmen: They were mean. Not polite. Big mad man. The stealers. Trying to own the place. The villains and it was so goody-goody; kids will know right from the start that the good guy wins; it's too obvious.	9%	13%	4%
When the kids got put in jail: They didn't do anything. They did nothing to get in jail. Not nice.	6%	7%	6%
Stole eggs: That was wrong and mean. I do not like it when people steal.	4%	7%	2%
Poddle people: How the little people looked weird.	3%	3%	2%

Appeal of Jackie, Matt and Inez

Viewers were asked to give one or two words to describe the personalities of the three kid characters. Descriptors garnering more than 5% of the sample's support are presented under the characters in the table that follows. There were very few true negative descriptors for any of the three characters. The top descriptors for Jackie were "smart" and "funny;" for Matt were "cool" and "smart;" and for Inez were "smart" and "nice, helpful."



Descriptors for:	**Jackie**	**Matt**	**Inez**
Smart	**28%**	**20%**	**55%**
Funny	**19%**	13%	
Nice, Helpful	10%	8%	**13%**
Cool	8%	**27%**	
Adventurous	6%		
Problem solver	5%		6%
Forgetful		7%	
Happy		5%	
Weird, Goofy		5%	

RESULTS: AGE APPROPRIATENESS

The pilot show was targeted for the appropriate age groups. In choosing who would watch the series, 79% of the sample felt that *Cyberchase* was for kids their own age, 68% felt it was also for younger kids and 29% felt that older kids would watch the series.

Respondents were asked who will watch the series on TV. Students could circle any or all of three responses (see table below). Large portions of students in both the third and fourth grades felt the series was for kids their own age or younger. There were some significant relationships: viewers who felt that the series was for younger kids were more likely to be white students, and respondents who felt that the series was for kids their own age were more likely to like solving pattern problems.

Who will watch this series on TV?

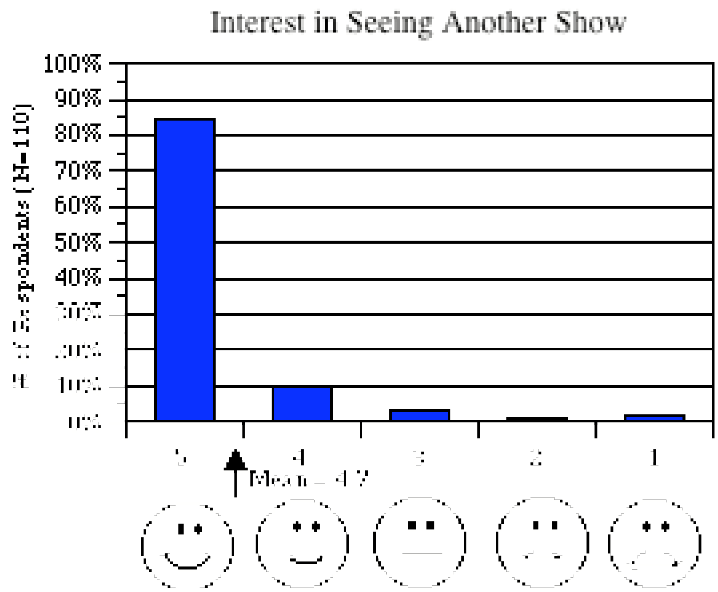
	N =	Kids younger than me	Kids my age	Kids older than me
Third grade	64	63%	85%	23%
Fourth grade	54	74%	72%	35%
All	114	68%	79%	29%

RESULTS: MOTIVATION

Almost all viewers (95%) wanted to see another show in the series. Interest in seeing another show was correlated with appeal of doing the previewing pattern problems. Interest in trying to solve pattern problems was high both before and after seeing the show. Viewing the show did not elicit significant positive or significant negative change in the children's motivation to try solving pattern problems.

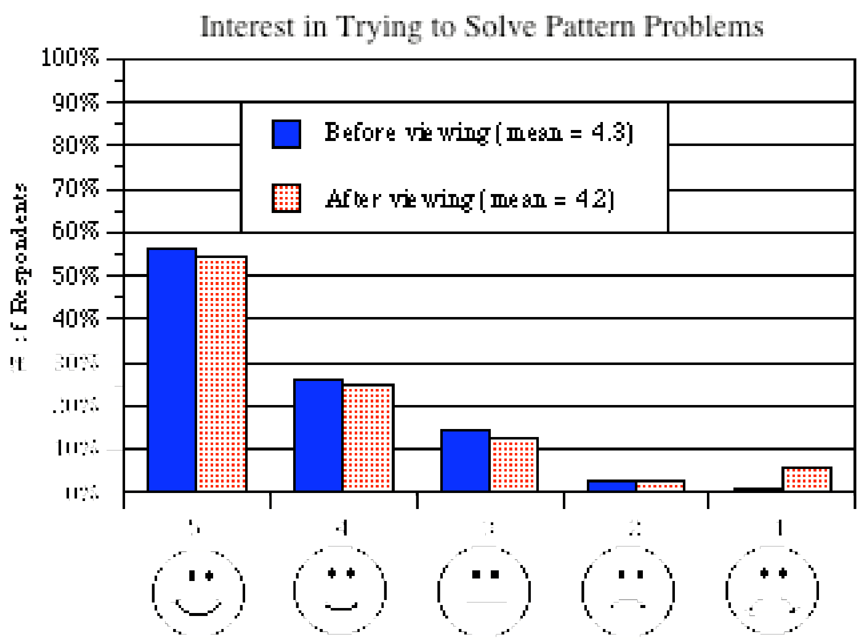
Interest in Seeing Another Show in the TV Series

When asked how much they wanted to see another show in this television series, 85% of viewers circled a "very happy" face and 10% circled the "sort of" happy face (see chart). The mean response was 4.7 out of 5. These results are as high or higher than those obtained in formative evaluations for children's series currently airing. The responses were independent of all demographic variables. Interest in seeing another show was correlated positively with appeal of doing the previewing pattern problems (r = .41).

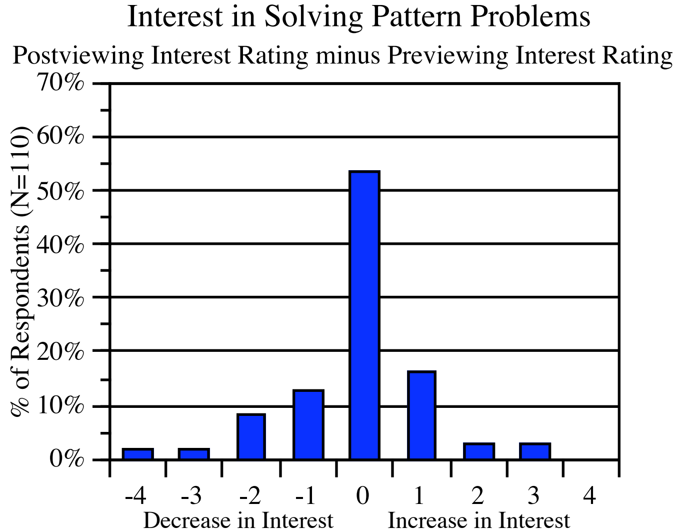


Interest in Trying To Solve Pattern Problems

Before viewing the show, students were asked to solve three pattern problems (see p. 14) and then to rate how much they liked trying to solve those problems. After the show, students rated how much they wanted to try to solve pattern problems like the ones they saw in the show. The chart to the right indicates that the "very happy" face was circled by 56% before the show and 55% after the show. The mean rating before was 4.3 and after, 4.2.



Mean ratings for interest in science content and activities in children's shows typically range from 3.0 to 4.5; thus, the ratings for this show are on the high side at 4.3 and 4.2. Viewing the show did not elicit a significant positive or significant negative change in motivation to try solving pattern problems. The chart to the right shows changes in students' ratings of interest: 22% of the sample showed increased interest in trying to solve pattern problems whereas 24% showed decreased interest and 54% did not change in their interest rating.



RESULTS: COMPREHENSION OF MAIN PLOT EVENTS

The main plot events were understood. Most of the interviewed students could recall that patterns were to be solved to access Motherboard and to enter the park and vault, and one-third could recall specifics of the pattern solutions. The story-retelling procedure revealed that 50% of viewers remembered that the kids had to solve a pattern to access Motherboard; 42% could tell us that Hacker was stealing the eggs to gain access to the vault; 67% recalled that the team had to solve a pattern to get into the park; 33% observed that the kids used a circle and a triangle to complete the pattern; 100% were aware that a pattern had to be solved to enter the vault. When asked to describe the solution, 58% focused on the final solution of using Poddle #1 in the egg lock whereas 33% could describe specifically how the kids solved the double pattern.

At the Oregon site only, 12 students, six per grade, were interviewed about the main plot events. Of the 50 students who viewed the show, 12 (24%) made errors in the previewing pattern solving questions. Five students (1 third, 4 fourth) with the most conspicuous errors were included in these interviews; these five either answered "don't know," omitted shapes in the double pattern or used wrong numbers in the sequences. The individual interviews were conducted to gain insight into whether the children understood: a) the basic Cyberchase storyline, b) the fact that the characters solved patterns, and c) how the kids solved the patterns. The researcher began the session with: "I would like you to tell me the story of the television show, starting at the beginning when Jackie was in her kitchen." The researcher encouraged students to continue with the prompt: "What happened next?" If the student did not cover the following content areas, the researcher then asked specifically:

- What was Hacker doing to Poddleville?
- What did the characters have to do to get into the park?
- How did the kids solve the pattern to get into the park?
- What did the characters have to do to get into the power plant?
- How did the kids solve the pattern to get into the power plant?

Students interviewed closer to the time of viewing recalled more of the storyline than did those interviewed later. Interviews began after the whole class completed the posttest and averaged 10 minutes in length. Thus, the first student in each grade was interviewed 20 minutes after viewing while the last student was interviewed nearly 80 minutes after viewing. While no obvious content differences were noticed in viewers' remarks, students interviewed earlier in the session tended to produce longer story retellings and their accounts included more incidental story information.

No major grade or gender differences were apparent in the storytelling responses; however, boys seemed somewhat more likely than girls to focus their story retelling around the pattern solving scenes of the story. Girls tended to include more contextual information in their retellings and were more likely to discuss scenes that did not specifically involve pattern solving. Girls more frequently described, for example: the kind of foods Jackie was preparing in her kitchen at the beginning and end of the show; the physical characteristics of Poddleville; the official egg count scene in the park; and the scene in which Jackie was disguised as a little egg.

Some name recognition issues arose in the retelling procedure, although these did not affect understanding of the plot. Students referred to Motherboard as "Mother Nature," "Mother lady," or "Mother." Most students used the name "Planterville", or "Planter-land," instead of Poddleville. Students did not recall Hacker's name, and referred to the poddles as "Martians" or "aliens." Finally, at least some viewers apparently did not understand that the show was set in cyberspace. Several students described the setting as "outerspace" or "another century."

<u>What was Hacker doing to Poddleville?</u>

All twelve respondents described some aspect of Hacker's evildoing in Poddleville. Less than half the students (42%) verbalized, with and without prompting, that Hacker was stealing the eggs to gain access to the cyberpower reactor vault or that his ultimate goal was to drain Poddleville of power and rule Cyberspace. Most frequently, students pointed out that he was stealing the town's eggs. Some confusion over Hacker's reason for stealing the eggs was evidenced, as a few students reported that Hacker simply intended to keep the eggs.

During their initial retellings, three of the 12 students (25%) spontaneously addressed what Hacker was doing to Poddleville. All three observed that Hacker aimed to drain Poddleville of its power, as follows:

> 1) "There was this mean guy with his two assistants who wanted to take control of that town so they could suck out all its power." (3rd grade white female)
>
> 2) "That bad guy was trying to steal the eggs so he could crack the cyber code thing to get all the cyberpower . . ." (3rd grade white male)
>
> 3) "They could figure out the code and it would give them all the power. He could take over and get all their power to rule everything." (4th grade minority male).

Student #2 made the connection that Hacker was stealing eggs to crack the code so he could access the town's cyberpower. Student #3 (who had pattern solving errors on the pretest) went a step further by observing that Hacker had a larger goal in mind.

The nine students who did not discuss Hacker's meddling in Poddleville as part of their story retelling were prompted with the question: "What was Hacker doing to Poddle-ville?" All nine initially returned the question with some version of: "Who was Hacker?" Once identified as the central villain/bad guy in the story, the students explained that Hacker was trying to: "steal the eggs" from Poddleville (5); get rid "of the kids" (2); "destroy" Poddleville (1); or "take it over" (1). Among the five who discussed Hacker's egg stealing effort, two reported that Hacker sought eggs to gain access to the vault so he could drain Poddleville of power and rule Cyberspace, and three students reported that they didn't know why Hacker wanted the eggs or that he took them because "he wanted to store them" or because they were "valuable." Similarly, the student who observed that Hacker intended to "take over" Poddleville was uncertain about the villain's use for the eggs and did not address Hacker's ultimate goal of ruling Cyberspace.

<u>Solving a pattern to access Motherboard</u>

In the initial story retellings, six students (50%) spontaneously recalled that the team had to solve a pattern to access Motherboard. Because no probe question was planned or used for this segment of the show, we do not know how many students would have remembered this event with prompting.

During the initial story retellings, half of the students (50%) recalled that the kids had to solve a pattern to access Motherboard. Students did not specify the nature of the pattern, nor that it was a numbers-only pattern, but most did recall that the kids successfully solved this pattern and were therefore able to consult Motherboard, if only briefly.

<u>What did the characters have to do to get into the park?</u>

With and without prompting, eight of the twelve students (67%) could recall that the characters had to solve a pattern to get into the park.

Without prompting, four respondents (33%) recalled that the characters had to solve a pattern to gain admittance to the park. Half of these students focused solely on the fact that a pattern had to be solved, as in: "So they walked to the force field thing, that park, and they put the pattern in and then they went through a gate and were at the meeting."
Only one student in the entire sample spontaneously mentioned any specific information about the nature of the pattern itself: "They tried to figure out the pattern to get into the park; I think it was triangle, square, circle, like that, and the gate opened and there were Martians with eggs in there." Interestingly, this fourth grader answered "don't know" on the first two pattern solving questions in the previewing test.

Given the prompt question, "What did the characters have to do to get into the park?" half of the remaining eight students correctly recalled that a pattern had to be solved, as in: "They had to figure out a pattern so they could go through the red gate." In two cases, students noted that the pattern involved shapes: "They had to put shapes in a board type thing to get in there." The other half of the eight students did not remember.

How did the kids solve the pattern to get into the park?

When asked how the kids solved the pattern to get into the park, 33% recalled that they used a circle and a triangle to solve the pattern; 50% responded that they "just figured it out;" and 17% could not answer.

During their initial story retellings, no one discussed how the kids solved the pattern at the park. When prompted with the question "How did the kids solve the pattern to get into the park?," four students (33%) observed that the kids used a circle and a triangle to comply with the pattern. For example:

> "They put a circle and a triangle in there." (4 grade minority male)

> "They had to put the next two shapes in. They did it by plugging in a circle shape and then a triangle." (3 grade white female).

Half the respondents (50%) answered with a version of: "They just got the rest of the pattern figured out." The remaining two students could not answer the probe question. The students discussed no other pattern solving procedures.

What did the characters have to do to get into the power plant?

With and without prompting, all students (100%) were aware that a pattern had to be solved to enter the vault.

Eight of the twelve viewers (67%) spontaneously reported that the characters had to solve a pattern to enter the cyberpower reactor vault, as in: "They went to the power place, then they went there and they did crack the code so they could open the door." One viewer observed that the characters had to solve a pattern that involved both shapes and numbers: "They were doing a code with shapes and numbers to get in there."

The four viewers who had not spontaneously mentioned the characters' entry to the power plant were then prompted with the question: "What did the characters have to do to get into the power plant?" Some confusion over the term "power plant" was evidenced at this point, as three students noted that the characters simply walked into the power plant, and only had to solve a pattern at the entrance to the cyberpower reactor vault; for example:

> "They just walked in. Like the 3 bad guys did. Then they had to crack that egg code thing to that special room." (4th grade white male)

> "You don't have to do a pattern to get in. I think you push a button and the door opens. They just had to do the egg code to get into the power room." (3rd grade minority female)

The final viewer also addressed the fact that a pattern had to be solved: "They had to figure out another one of those patterns."

How did the kids solve the pattern to get into the power plant?

With and without prompting, 33% of the interviewed students could describe how the team solved the double pattern of the egg-lock. Another 58% focused on the final solution of using Poddle #1 in the lock.

Eight of the twelve viewers (67%) independently discussed how the kids "cracked the code" to the cyberpower vault. Half of these students focused their comments on the following three pattern attributes: the fact that the pattern was a double pattern (shapes and numbers); that it only involved odd numbers; and that the numbers ran in descending order. For example:

> "They were trying to put the eggs in order. They had to put them all in order. There was also some pattern of the shapes. I forgot what that was. They took every number that was odd and they went from 11 to 1 and got it before the villain." (3rd grade minority female)
>
> "By counting down by odds and getting the shapes in the right way. They had to get both right." (4th grade white male)
>
> "She and Jackie took the eggs and they figured out how to do the code. They did it in an odd number way. They were stuck and they called out on the communicator. Inez helped. She said to put a #1 in there. Jackie said we need a triangle #1. They put the girl in and it worked" (3rd grade white female).

The other half of the spontaneous descriptions focused on Jackie's insertion of the triangle #1 poddle into the final slot in the egg lock. For example:

> "They cracked that code by using the little #1 guy. Jackie tried the #1 Martian in the hole and it worked." (4th grade white female)
>
> "So the triangle #1 guy, Jackie picked him up and put it in so they broke the cybercode." (3rd grade white male)

The probe question was asked of four students (of whom three had previewing pattern solving errors). Three students focused on the insertion of the poddle #1 in the final slot of the egg lock, as in: "The little #1 guy, they put him inside and it worked." The fourth student observed that the kids copied the early part of the villains' pattern and then worked out the pattern from there: "They solved it by copying what the bad guys did and then figuring the rest of the pattern out on their own" (4th grade white female).

RESULTS: PERCEIVED LEARNING

When asked what they learned from the show, 25% reported learning about patterns or math; 11% learned how to figure out patterns better; 11% said they knew it all before or learned nothing; 9% learned not to steal, be nice; 6% learned that patterns can also be in shapes; 5% learned to think hard; and 4% said they learned what odd numbers are.

Students were asked to write down two things that they learned from the show. Most students (76%) could write one thing, and over half (54%) could think of two things. 11% of the sample, mostly fourth graders, specifically stated that they learned "nothing;" that they "knew it all before." The table below lists the categories mentioned by more than 3%. One quarter of the students simply wrote that they learned about "patterns" or about "math," with no further elaboration. Another 11% felt that they learned "how to figure out patterns better." The moral lesson of not stealing and being nice was put forward by 9%.

What Viewers Thought They Learned from the Show

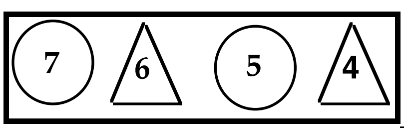
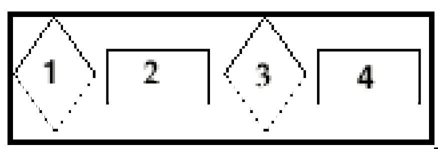
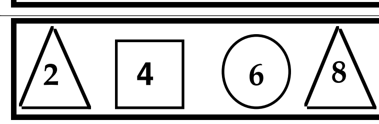
What was learned: example comments to demonstrate range, not quantity	**All N=228**	**First Thing n=114**	**Second Thing n=114**
About patterns; about math: Patterns. More about patterns. Math. Math patterns.	25%	31%	20%
How to figure out patterns better: How to solve patterns better. How the best way to solve patterns. How to solve hard problems.	11%	12%	9%
Don't steal; Be nice: To be nice. You should not steal.	9%	11%	6%
Patterns can also be in shapes: Not all codes are just numbers. Patterns can be shapes and numbers. New patterns of shapes. Shapes are patterns too.	6%	6%	6%
Think hard: To think hard. To look at things more carefully. Intelligence pays off. Brain power does a lot more than you think.	5%	4%	6%
What odd numbers are: Odd numbers are 11, 9, 7. To count down odds from 11 to 1.	4%	6%	1%

RESULTS: CHANGES IN PATTERN SOLVING ABILITY

A 3-item pattern-problem test administered before and after viewing yielded unreliable results due to a ceiling effect and non-equivalent pre-post problems. Three-quarters of the tested sample could solve all the problems on both tests. About one-fifth of the sample could give a coherent explanation of the solution to a number and shape pattern both before and after viewing *Cyberchase.*

A 3-item test was developed to assess ability to solve patterns similar to those in the show. The test was administered to DE students (n=64) before and after viewing the program. Limitations in time and budget supported this plan; but as it turned out, the test as a whole was too easy for the sample leading to a ceiling effect, the pretest items were not equivalent to the posttest items in difficulty nor were three items a sufficient number to make a reliable test. Thus, the following test results should be looked upon with caution and skepticism.

The Poddleville Case included a number-only pattern (Fibonacci numbers); a shape-only pattern (3 shapes) and a double pattern (3 shapes, descending odd numbers). A similar but easier three patterns were used in the pre and postviewing tests, as shown below. A fourth pattern with 3 shapes and a number sequence to mimic the egg-lock problem was added to the posttest. Students were instructed to "look at the pattern. In the spaces, write in the next two numbers/shapes in the pattern." If answers continued the sequence given, they were scored correct. Three-quarters of the students could solve all three problems on both tests, indicating that the test was too easy for reliable conclusions to be made. The percentage correct for the sample of 64 students for each item is shown in the table.

Previewing Items	% Correct	Postviewing Items	% Correct
2 4 6 ___ ___	95%	3 6 9 ___ ___	84%
◇◇□◇◇□◇__	95%	×ΔΔ×ΔΔ×_ _	100%
 _ _	80%	 _ _	92%
		 _ _	74%

Using paired-sign tests, we looked at each item to determine whether there was a significant change in individual students' answers from pretest to posttest. On the numbers-only problems, a significant number of students were correct on the pretest but <u>in</u>correct on the posttest. Most of the incorrect answers on the posttest appeared to have more to do with poor arithmetic than with lack of pattern recognition, thereby making these results suspect for a conclusion about pattern-solving ability (e.g., answers included 11-14; 12-13; 12-14; 12-16). Pre-post performance on the shapes-only patterns did not differ, due to a ceiling effect. On the pre-post double patterns with two shapes, a significant number of students were incorrect on the pretest and correct on the posttest. On the pretest, these students forgot to include the shapes with their number answers, but on the postttest they included the shapes.

On the post-test only double pattern (see table above), 74% answered successfully. An analysis of incorrect responses indicates that 15% used the wrong sequence of shapes. Possibly three shapes in a pattern was more confusing than two.

In the pre and posttest, students in the Delaware sample were asked to explain, as best they could, how their answer to the third problem (double pattern, two shapes) continued the pattern of shapes and numbers. The table below presents the distribution of categories of the explanations for both the pretest and posttest number-shape pattern questions. About one-fifth of the sample was able to explain their answers coherently.

Pre test %	**Post test** %	**Category of Explanation of Number-Shape Pattern**	**Examples of Category**
34%	19%	Reference only to number pattern: Numbers count down/up	"You are counting backwards 76543210" "Numbers just get lower" "Counted down from 7 until I got to #2"
27%	47%	Looked at it; Just knew it	"You look at them and it gives it to you right away" "Just looked at the pattern and finished it" "I knew the pattern of numbers and shapes"
19%	20%	Coherent explanation of both number and shape patterns	"Pattern goes circle, triangle, and has numbers in it going down from 7" "The shape pattern was an AB pattern and the numbers were counting down" "Numbers backwards by one and it went circle, triangle"
6%	3%	Reference only to shape pattern	"First is a circle, then triangle, circle, triangle, etc." "The circle and triangle are like taking turns"
6%	2%	Coherent explanation of number pattern but not of shape	"The numbers go down and the shapes continue" "By counting backwards and then put what comes after the last shape"
8%	9%	Miscellaneous	"I know and like math a lot" "It goes on and on"

RESULTS: CHILDREN'S UNDERSTANDING OF PATTERN PROBLEMS

Of the Oregon students who generated their own pattern using numbers and/or shapes, 70% said that watching the show helped them make the pattern, 10% said that the show did not help, and 20% did not answer the question. The instructions did not specifically say that the pattern had to repeat, but we coded the students' patterns on the assumption that the kids would understand this from the context of the show and previous previewing test examples. Given our coding scheme: 6% generated a number-only pattern that correctly repeated or sequenced; 12% drew a repeating shapes-only pattern; and 52% showed a repeating double pattern of numbers and shapes. Students who were interviewed felt that the show had helped them make a pattern because it told them what a pattern was, gave them the idea of using shapes, gave them the idea of using numbers inside shapes, or showed them that a pattern could have numbers being added up inside the shapes.

After viewing the show, students in the Oregon site were asked to generate their own pattern, as shown below:

> The kids in the show saw patterns of numbers and patterns of shapes. They also cracked the code to the vault by completing a pattern of both numbers and shapes. Draw YOUR OWN pattern code in the six spaces below, using numbers or shapes or using both numbers and shapes. Fill all six spaces with your pattern.
>
> _________ _________ _________ _________ _________ _________
>
> Did watching the show help you make the pattern you drew above?

The instructions did not specifically say that the pattern had to repeat, but we coded the students' patterns on the assumption that the kids would understand this from the context of the show and previous previewing test examples. Students' patterns were coded by their use of numbers or shapes, by type of numbers and number of shapes, by correct or incorrect sequencing or repetition in numbers or shapes. The table that follows shows the distribution of these categories. The major results include:

- 6% generated a number-only pattern that correctly sequenced or repeated;
- 12% drew a repeating shapes-only pattern;
- 52% showed a repeating double pattern of numbers and shapes.

Viewing the show probably influenced the 52% of students who chose to generate the more complicated double pattern In fact, three-quarters of the Oregon sample (70%) said that watching the show helped them make the pattern, 10% said that the show did not help, and 20% did not answer the question.

Categorization of Post-Viewing Patterns Generated by Oregon Sample

Numbers	Number seq/repeat	Shapes	Shape repetition	% (n=50)[1]
No numbers	-	2 shapes	Repeat	4%
	-	3 shapes	Repeat	6%
	-	"	No Repeat	2%
	-	4 shapes	Repeat	2%
Even numbers	Correct Sequence	No shapes	-	2%
	"	1 shape	-	2%
	"	2 shapes	Repeat	4%
	"	"	No Repeat	2%
	"	3 shapes	Repeat	22%
	"	"	No Repeat	4%
	"	4 shapes	Repeat	2%
Odd numbers	Correct Sequence	No shapes	-	2%
	"	2 shapes	Repeat	2%
Number sequence (e.g., 2 3 8 2 3 8)	Repeat	1 shape	-	2%
	"	2 shapes	Repeat	2%
	"	3 shapes	"	8%
	"	4 shapes	"	2%
		3 shapes	"	2%
Number sequence, adding or subtracting (e.g., 5 10 15 20 25 30)	Correct Sequence	No shapes	-	2%
	"	2 shapes	Repeat	4%
	"	3 shapes	"	4%
Random numbers; letters (e.g., 11 9 8 7 5 3; E A B C L M)	No Repeat/Seq	2 shapes	Repeat	4%
	"	3 shapes	"	4%
	"	4 shapes	"	2%
Mix of numbers, shapes, no repeat				8%

[1] Rounding of percentages will make this column add up to more than 100%.

Interviews about Patterns Generated After Viewing Show

Seventeen of the 50 Oregon students were interviewed about the pattern that they generated in answering the question discussed above. Twelve of these students were able to generate Repeat patterns on the post-viewing questionnaire. Most of these students formed patterns that used a combination of shapes and numbers. The following grade differences were observed:

- Every third grader (n=7) was able to draw a pattern, and all but one student generated a pattern that used both shapes and numbers. A shapes-only pattern was drawn by the one exception, who had had pattern solving errors on the pretest.

- Half of the 10 interviewed fourth graders generated complete patterns. One of these students used a numbers-only pattern, another a shapes-only pattern, and three students used numbers and shapes together. The one female student who performed poorly on the pattern solving portion of the pretest correctly generated a pattern that used shapes (circle, triangle, square; circle, triangle, square).

- The other half of the fourth graders (n=5), all males, produced shapes-only or shape and number drawings that did not form discernible patterns. Three of these five students had pretest pattern solving errors. When interviewed about their drawings, each of the five offered explanations as to why their drawing constituted a pattern, as follows:

  Two of the five students explained that they made a shape-based pattern that consumed all six spaces provided in the questionnaire. They argued that they were not asked to repeat their pattern and that the questionnaire "needed more spaces", if they were expected to "show the pattern repeat itself." One of these students who also used numbers in his drawing (presented in no discernible sequence) further commented: "The numbers didn't matter to my pattern. They could have been any numbers. Only shapes counted."

  The third student rationalized that he had generated a pattern, but that the first item he listed on the questionnaire was actually from the middle part of his pattern: "My pattern starts with those ones in the middle, not the first one I got down there. It just repeats from that point." With respect to a numerical error the student made on the last item in his pattern, he stated he "just made a stupid mistake" on the last item and had "miscounted."

  The fourth student, who had produced a drawing using both shapes and numbers, commented that he "accidentally" drew the wrong shape for the last item and that he put numbers inside the shapes that didn't go in any certain order because: "they weren't important to the pattern, only the order the shapes go in."

  The fifth student who drew a variety of shapes without attention to order argued that his drawing was a pattern because: "I only used certain shapes, not just any old shapes, just certain shapes: triangles, circles, diamonds, and squares."

The following section summarizes the students' answers to all the interview questions.

Tell me about the pattern you drew.

In response to the instruction "Tell me about the pattern you drew," the 17 viewers most frequently: restated the contents of their pattern (n=8); explained their pattern's characteristics (n=5); or could not answer the question (n=4). Examples types of response follow:

- Restated pattern: 47% of those interviewed simply recited the items they had included in their pattern. In each case, the students read their pattern aloud, item by item, as in: "I drew a triangle, circle, triangle, circle, and then I had some numbers. Just 9, 8, 7, 6 . . . like that."

- Explained pattern's characteristics: 29% of the students explained their pattern's characteristics. These students generally focused on the fact that their pattern featured numbers that increased or decreased by certain increments. Where shapes were used, students observed that they placed these shapes in a certain order and that their drawing constituted a pattern also because it "repeated" this sequence of shapes. Examples include:

  "I went by 4's higher and higher. Then I just repeated all my shapes in the order I had them in." (3rd grade white male)

  "I just kept adding 5s. I started with 5s and just kept going up. 5,10,15, 20, like that." (4th grade minority female)

  "I started with a triangle and a 12, then I figured out I wanted to count down by 2s and have my pattern have 3 different shapes repeat like this: triangle, square, circle." (4th grade minority male)

- Did not understand question: The remaining students (24%; 2 males per grade) did not answer the question, reporting that they did not understand or "get" the question. In these cases, the interviewer proceeded to the probe question below.

No major gender or grade differences were apparent in the above responses. With respect to the five students whose drawings did not represent complete patterns, three did not understand the question and two simply restated their drawings.

What makes it a pattern? Why is it a pattern?

Five of the 17 students explained their pattern in the above question. Of the remaining 12 students who were asked the follow-up probe: "What makes it a pattern?," six again restated their pattern but six could explain. Respondents focused on the fact that the shapes and/or numbers in their patterns repeated themselves. Examples include:

> " I don't know. It just keeps doing the same thing over." (4th grade while female)
>
> "It's not like a bunch of different shapes and all. It repeats itself. The shapes and numbers do that in my pattern." (3rd grade white female)
>
> "Because it keeps repeating the same thing over and over again." (3rd grade white male)
>
> "Because the same things are being repeated. The shapes and numbers repeat. The numbers go up 4 by 4, they get added like that, and I always give just 3 shapes. They keep repeating."

No major gender or grade differences were apparent in the responses. With respect to the five students who did not produce complete patterns, two restated their patterns at this point, while the remaining three students attempted to explain their pattern in terms of "something that repeats." In summary, with and without prompting, 65% (11/17) could explain why their drawing was a pattern.

If I wanted to draw another piece of your pattern here, what would I draw?

When asked to identify the next piece that would follow in their pattern, all of the students who generated patterns on their posttest completed this task correctly. Of the five students whose drawings were not judged to be complete patterns prior to the interview, two noted an error in the last item of their pattern at this time:

> "Oops. That was supposed to be a triangle, not a circle, that last one there. I messed up." (3rd grade white male).
>
> "Oh, oh. I meant to have a zero then. I wasn't thinking." (4th grade white male)

The two students who stated that their patterns used all the available spaces on the questionnaire (to explain why their patterns didn't repeat on the questionnaire) identified the first item in their pattern as the piece that would follow next. Finally, the student who contended that a pattern could simply comprise "the use of certain shapes" reported that "you could put in any of the shapes in my pattern, if it's one of my shapes."

Why can't I draw (researcher gives an No Repeat answer) in that spot?

Students were next asked "Why can't I draw (No Repeat answer) in that spot?"
All 12 students who generated patterns on their posttest explained that the suggested item did not "fit" or "go" with their pattern. For example:

> "Because I wasn't using that number in my pattern. It doesn't fit." (4th grade white female)
>
> "It isn't in my pattern. It doesn't go with the way I set it up." (3rd grade white female)
>
> "Because you need a triangle next. You just do, to make it fit." (3rd grade white male)

Most students provided more specific detail as to why the suggested item wouldn't work in their pattern. Many focused on the fact that the item would interrupt the numerical sequence they established. Examples follow:

> "It wouldn't go with my pattern. It would throw it out of whack. It doesn't go by 4's and that shape doesn't fit with my pattern." (3rd grade male)
>
> "It wouldn't be even to all the other ones." (4th grade minority female)
>
> "[suggested No Repeat answer = 1] That's an odd number. You wouldn't put an odd number in my pattern. You wouldn't have a pattern then." (4th grade minority male)
>
> "[suggested No Repeat answer = 12] Because my pattern is going by twos. That wouldn't go with it. A 12 is just one more, not two more." (3rd grade white female)

No major gender or grade differences were apparent in the responses. With respect to the five students who generated drawings that were not judged to be discernible patterns, all responded to this question with a version of "That's not part of my pattern. That would throw off my pattern."

Did the show help you make this pattern?

All but one viewer felt that the show helped them make their pattern. Students cited four reasons, including: "told me what a pattern was" (n=6); "gave me the idea of using shapes" (n=5); "gave me the idea of using numbers inside shapes" (n=4); and "showed me that a pattern could have things being added inside it" (n=2). Examples of each response type are included below:

- Told me what a pattern was 35%
  "It showed me that a pattern is--what a pattern is. That it repeats itself." (3rd grade white female)

  "Yes. I don't know how. It just showed different stuff you could do with patterns." (4th grade white male)

- Gave me the idea of using shapes 29%
  "It gave me an idea about using shapes. I would have just used numbers. I wouldn't have used shapes, just plain numbers." (3rd grade white male)

  "It gave me different ideas for shapes. Using shapes in patterns." (4th grade white male)

- Gave me the idea of using numbers inside shapes 24%
  "It helped me figure out what kind of pattern to make and how to make it. I mean, it showed me how to use numbers inside of shapes." (4th grade minority male)

  "It helped me. Figuring out how to make patterns. If I made patterns, they wouldn't be like this. It showed how to make them with numbers and shapes together." (3rd grade white male)

- Showed me that a pattern could have things being added inside it 12%
  "It showed me that a pattern could have things adding up in the pattern--that you can add things in a pattern, or I mean have them like adding certain numbers together to get the next number in the pattern. Like that and have that repeat too as a pattern." (3rd grade white female).

Of the interviewed sample, girls were somewhat more likely than boys to attribute the show's helpfulness to the fact it defined/explained patterns, while boys were more likely to point to the fact that the program showed them how to make patterns using shapes and/or numbers inside shapes. With respect to the five students whose drawings did not represent complete patterns, two focused on the fact that the show defined and explained patterns, while the remaining three students reported that they learned how to make patterns using shapes.

DISCUSSION

The quantitative appeal results were very high and compare favorably to findings in formative evaluations for shows that are being aired on television currently. *The Poddleville Case* appealed to 96% of the third and fourth graders, with 88% liking the show very much. The overall mean appeal rating was 4.8 out of 5 on the 5-point face scale. Almost all of the sample (95%) was interested in seeing another *Cyberchase* show, with 85% being very interested. Appeal of the show and interest in seeing another show was correlated positively with interest in solving the previewing pattern problems.

Viewing the show did not elicit significant positive or significant negative change in the children's motivation to try solving pattern problems. Interest in trying to solve pattern problems was high both before and after seeing the show: 56% of the sample were very interested in solving patterns before seeing the show and 55% were very interested after the show. Mean ratings for interest in science content and activities in children's shows typically range from 3.0 to 4.5 on a 5-point scale; thus, the ratings for this show are on the high side at 4.3 before viewing and 4.2 after viewing.

In the qualitative appeal results, one-fifth of the sample liked the "whole show" and did not identify a "best part," whereas others applauded the egg-lock pattern-solving segment, the poddles, and the patterns in general. The few negatives raised about the show were elements inherent in a good guy-bad guy tale; that is, some students did not like the bad guys, the stealing of the eggs and seeing the kids in jail. The team of kids was described almost unanimously in a positive manner as "smart," "funny," "nice and helpful," "cool" and as "problem solvers." The show appears to be targeted for the right age group according to our sample. The majority felt that the show was for kids their own age (79%) or for younger kids (68%). Many fewer students (29%) felt that the show was for older kids.

The main plot events of *The Poddleville Case* were understood. Most of the interviewed students could recall that patterns were to be solved to access Motherboard and to enter the park and vault, and one-third could recall specifics of the pattern solutions for getting into the park and for opening the vault. Given the high pattern solving ability that students demonstrated before viewing the program, it is likely that viewers understood the specifics of the solutions at the time of viewing, even though they all could not recall them for the interviewer in their story retelling.

When asked what they learned from the show, 25% reported learning about patterns or math; 11% learned how to figure out patterns better; 11% said they knew it all before and learned nothing; 9% learned not to steal, be nice; 6% learned that patterns can also be in shapes; 5% learned to think hard; and 4% said they learned what odd numbers are.

Of the patterns that students generated on their own after viewing the show, 70% showed repeat pattern features: 6% number-only patterns; 12% shape-only sequences; and 52% double patterns of numbers and shapes. Of those who made patterns, 70% felt that the show helped them draw a pattern, 10% said that the show did not help, and 20% did not answer the question. Students who were interviewed felt that the show had helped them make a pattern because it told them what a pattern was, gave them the idea of using shapes, gave them the idea of using numbers inside shapes, or showed them that a pattern could have numbers being added up inside the shapes.

A 3-item pattern-problem test administered before and after viewing yielded unreliable results due to a ceiling effect and non-equivalent pre-post problems. Three-quarters of the tested sample could solve all the problems on both tests. A large portion of viewers were good pattern solvers to begin with. The program reinforced what they knew already, gave them more practice and helped them automatize their skills. About one-fifth of the sample could give a coherent explanation of the solution to a number and shape pattern both before and after viewing *Cyberchase.* The show did not improve students' abilities to articulate problem-solving verbally but neither did it confuse them.

In the development of the epilogue for *The Poddleville Case*, it would be useful to keep in mind the high interest in problem solving, the willingness of students to expand their horizons to more complicated problems and the limited ability to verbalize what makes a pattern, a pattern. For example, the epilogue might review pattern solving by replaying segments of the show where the characters are voicing the definition of a pattern or explaining the thought process of solving a pattern problem. A voiceover of one of the team, or a conversation among team members, could summarize lessons learned in their solution of the case. Or, in a modeling format, the epilogue could present a complex problem on-screen for the viewer to think about while off-screen voices discuss how to solve the problem and try out different solutions; this is a technique that has served *Sesame Street* well. Or, in a more active format, the epilogue could invite members of the viewing audience to practice their pattern-solving abilities by working through grade-level problems presented on-screen, in the way that *Square One TV* presented short fun practice segments like Pac Man eating his way through number problems.