Enhancing Children's Educational Television with Design Rationales and Justifications

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Submitted to the Program in Media Arts and Sciences,
School of Architecture and Planning,
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Abstract

This research involves creating a system that provides parents with tools and information to help children learn from television. Children who converse with their parents during television viewing are better able to evaluate and make sense of content. However, children might learn more if they are encouraged to go from simply understanding content to generating questions and problem solving strategies. To do this, we need to deliver teaching and learning strategies to parents so they can initiate dialogues with their children around television. This research describes a system, called the Parent Trap, which sends messages to parents about the television shows that their children watch. The information in the messages tries to model dialogues that promote more frequent and longer conversations, which include inquiry and explanation. These conversations might facilitate additional learning from television and encourage further discourse between parents and children around other programs and activities. In the thesis, I suggest ways that television shows can be augmented with additional, digital information to help parents learn strategies for conversing with their children. I also present preliminary evaluations to show that developing these strategies may help television producers change the ways that they think about the educational value of their content.

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1 All I really need to know I learned from watching television…

Televisions are found in over 98% of households across the United States, Europe, and developing nations (Clifford, Gunter, & McAleer, 1995; Dowmunt, 1993). They deliver vast and varied amounts of information by broadcasting images, audio, and text (on-screen or through closed captioning). However, television is more than just a mechanism for delivering content and information; it is a social medium. It is a technology that influences many aspects of daily life, from shopping to cooking to sheer entertainment (Huston et al., 1992; Kubey & Csikszentmihalyi, 1990). In homes, television viewing usually occurs in common spaces — family rooms, living rooms, and eating areas — and this placement may not be accidental. Since the majority of all television viewing occurs in these rooms (Kubey & Csikszentmihalyi, 1990), the likelihood that people will watch together and talk about television as they watch increases.

The social interactions that occur around television can often enhance learning opportunities for viewers. For instance, we know that children can learn a great deal from educational television programs (Clifford et al., 1995; Dorr & Rabin, 1995; Huston et al., 1992; Huston & Wright, 1994; Wetzel, Radtke, & Stern, 1994). We also know that interactions with peers and parents during television viewing can change the otherwise "passive" viewing experience into one where children actively question content (Collins et al., 1981; Dorr et al., 1989; Dorr & Rabin, 1995; Haefner & Wartella, 1987; Salomon, 1977). The research presented in this document attempts to discover new ways to promote conversations between parents and children to create additional opportunities for learning with television.

Television can be useful as a source of instructional material. In schools, for example, science teachers use programs such as Bill Nye: The Science Guy to introduce concepts, conduct experiments, and discuss content (Rockman et al., 1996). Several educational programs also provide teachers' guides with lesson plans, ideas for classroom activities, and additional resources to guide instruction. These guides help teachers generate curriculum that extends the

content of a television program. ZOOM, a children's science and math series, for example, publishes an activity guide, which describes how to help children understand basic concepts in science (Latimore, 1999). It also provides information on scientific resources as well as instructions for activities and related science challenges that children can participate in. In conjunction with teaching strategies, these guides can help educators use televisions as instructional tools in classrooms. Helping parents understand the strategies that classroom teachers use might also transform televisions into learning tools in homes.

In home viewing, television can entertain children and excite curiosity about the world around them. It can also help children learn important information, skills, values, and behavior. For example, watching "Mister Rogers' Neighborhood" and "Sesame Street" teaches task persistence, imaginative play, and letter and number (Children's Television Act of 1990, Section 303a; Federal Communications Commission, 1996). While television may teach basic facts or behaviors, mediation during viewing by a knowledgeable adult can influence critical skills, such as comprehension and reflection of content (Dorr & Rabin, 1995). For instance, when mothers and their children watch Sesame Street together, the children understand more of the program's messages; the prompting and guidance that parents offer can lead children to think outside the program's content, to understand how the knowledge can be applied to other situations (Salomon, 1977).

The types of conversations that parents and children engage in around television are often more descriptive than explanatory (Desmond et al., 1990; Gunter & McAleer, 1997). That is, they describe an opinion about the show, such as, "That was good," or "Why are we watching this nonsense?" A more explanatory comment would involve reflecting on the content of the program. For example, when a child says, "I learned today that you can count the rings on a tree to tell its age," the response "That's nice," effectively ends the conversation. In contrast, a response such as, "How do scientists know that? Let's think about how they figured that out," invites further

discussion and exploration. These types of conversation treat television as a source of learning materials that must be supplemented with some sort of mediation or intervention by parents.

To promote interaction and explanatory dialogues, I try to help parents understand how to structure conversations by giving them better insight into the content of a television program. More importantly, I try to model question-asking and problem-posing strategies that they can use for other shows and for life in general. Parents and children can start to ask questions about the specific issues presented in a television program and generate explanations for how and why events occur in the world. Parents who are provided with information about programs and about how to ask questions that encourage inquiry and exploration may have greater success in initiating dialogues with their children around television content.

To generate information about content, I develop frameworks for television producers that make their tacit assumptions underlying programming decisions explicit. The frameworks are built around the main issues of a program, alternative issues that may not have been represented, and questions that might arise from the issues and alternatives. These three elements make up the design rationale of a television program, which describes how and why a show is meant to be educational. Design rationale is a methodology for articulating decisions behind engineering artifacts (Lee & Lai, 1991; MacLean et al., 1989; MacLean et al., 1991; Moran & Carroll, 1996). These rationales place emphasis on the process of creating a building, computer program, or graphical interface, recognizing that the decision process can be used by others to learn about the ultimate product. In my work, I borrow features, such as justification, from these methodologies to create rationales for television programs. In a similar way, I am trying to encourage television producers to articulate their decisions for including and discarding content during their editing process. If parents can comprehend the intentions of the producers, they may be able to understand the important lessons to help their children learn.

One goal of revealing rationales is to increase the communication between parents and children to assist learning from television. A second goal is to lead television producers to reveal their design rationales for educational content. That is, to think about the implications of decisions they make when developing content. The agenda that should be followed to accomplish these goals includes:

- **Developing a theory of justification that describes the content and rationale behind children's television programming.** What pedagogical and content issues need to be represented to describe the educational benefits of children's television? How can these features be communicated to producers to influence their design and production decisions? What types of tools are needed to represent and encode justifications into television broadcasts?
- **Assessing the impact of justifications on adult-child interactions and learning.** Can programs labeled with additional justifications affect the types of conversations that occur during co-viewing? Are children able to learn more through conversations when parents are provided with the knowledge encoded in design rationales? Are parents themselves learning more about inquiry and question-asking strategies when using justifications to converse with their children? Are these conversations moving away from simple evaluations of programs and becoming descriptive and explanatory commentaries?
- **Rethinking the content and design of educational television in light of these justifications.** As television programs are annotated with digital justifications, producers and content developers will explore new avenues in the area of production. For instance, Bill Nye: The Science Guy shows do not currently deal with explicit scientific inquiry, but as I began constructing preliminary justifications around the program, it became obvious that inquiry could be included as a topic in educational programs. Can we rethink the types of educational programming available to children and parents? How can digital technologies help television viewers become more active viewers?

The design rationales not only hold producers and broadcasters accountable for the educational programs they currently air, but they also act as a guideline for the production of future television shows. The guidelines are designed to lead producers through a series of questions to explain the educational content and design of their programs. Justifications are broadcast along with a program and used to produce investigation reports for parents and children. The reports consist of questions and strategies for specific episodes of television shows. They will hopefully serve as models of inquiry that increase the level of engagement and collaboration occurring between parents and children as they learn from educational television.

There are three target audiences that can benefit from including design rationales and justifications in television programs:

- **Producers:** By giving producers an ontology of pedagogical features and ways to justify their use, I hope to assist them in creating programs that better educate their viewers. That is, I hope to engage producers in critical thinking of and reflection on their programming decisions with respect to educational concerns. The hypothesis is that explicit guidelines will help producers engage in deeper reflection about their own conceptions of learning as they create educational content. Justifying the educational quality of children's programming might also convince parents of a program's quality and increase the viewing audience.
- **Parents:** Parents might be able to help their children learn if they are given the proper guidelines and scaffolding tools (Gleason & Schauble, 2000). During television viewing, mediation by knowledgeable coviewers influences children's understandings of program content (Dorr & Rabin, 1995; Salomon, 1977). Therefore, parents who have a better understanding of how and why particular programs are used to teach might play a more beneficial role in their child's television viewing. By encoding pedagogical information about a television show into the video stream, we can begin developing additional applications to help parents understand how their children learn. The intent is to model question-asking and inquiry strategies (Collins & Stevens, 1982; van Zee & Minstrell,

1997a; van Zee & Minstrell, 1997b) in the context of specific programs. For instance, by using encoded justifications, we can generate email and web-based "reports" that parents can use to engage their children in conversations about the day's learning.

- **Children:** Digital justifications for television also provide new opportunities for children. Justification elements can be shown to children before, during, and after broadcasts to help them question the content for themselves. Guided questioning during the program can assist viewers in developing inquiry skills around the content (Blumenfeld et al., 1991; Brown & Palinscar, 1989; Davis, 1996; King, 1994; Sandoval & Reiser, 1997). Information from design rationales can also be used to generate ideas for related activities in children's local communities. Part of this work will also think about augmenting existing program content so that it relies less on information transfer and more on engaging children in inquiry and problem solving.

In the rest of this thesis, I illustrate how social interactions around television can be increased to help children learn. To develop informal learning activities around television, I borrow features from educational reform movements, such as inquiry learning and teaching. I describe research to help parents enhance conversations they have with their children around television. I also explain the system that was built to encode digital information into television programs. With this system, called The Parent Trap, I help producers of children's television add information to their programs that justify content. Justification is important because it tells us why a piece of content is educational and how it is structured to be educational. I determine what types of questions will best guide content developers in justifying educational television content. I also create an indexing system based on these questions to document the justifications. I provide parents with details about the content justifications as well as additional information that equips them with a subsequent understanding of inquiry learning. The indexing system is used to annotate several children's and educational programs and is evaluated by a group of university students.

In chapter two, I give an example of The Parent Trap. Chapter 3 describes the theory behind the system, including research in educational television and education reform movements, such as inquiry learning. Chapter 4 discusses the design and technical implementation of the system. Chapter 5 summarizes the evaluation and student critiques, and finally, Chapter 6 concludes with a final overview and ideas for future work.

2 Scenario: Enhancing Educational Television

In this chapter, I give an example of The Parent Trap. I describe how the system delivers information to parents about the television show that their child is watching and how producers can use the system to annotate television programs.

2.1 Look at what I learned on TV today…

Imagine that a child comes home from school and turns on the television to watch Bill Nye: The Science Guy. Today's episode is about forests. Bill talks about the four levels of a forest: the canopy, understory, floor, and subfloor. He also shows how to tell the age of a tree by counting the rings in a cross section of its trunk. Two young scientists conduct an experiment to demonstrate how the life and energy cycles of forests work. By placing three celery sticks in colored water and exposing each of them to different environmental conditions, you can see how sunlight, wind, and humidity might effect the flow of water and nutrients to the tops of trees. A logger explains the process of logging trees and Bill talks about how wood is useful in everyday life.

After the first 17 minutes of the program, the child decides to turn off the television even though the show is not over. As a result the child misses seeing and hearing about the different types of forests that exist around the world, what a forest ecologist does, and how forest fires help renew the ecosystem. Luckily, an email message containing information about the show is automatically generated from justification structures embedded within the television program and sent to the parent. The e-mail message summarizes the issues and ideas in the portion of the episode that the child watched (i.e., up to where the child turned off the television), as well as in the portion that they missed. The message also includes suggestions for questions that parents can ask their children and a link to a website with annotated video clips from the show illustrating the main points of the episode. The e-mail appears something like this:

Subject: The Forest
Date: Fri, 16 Oct 1999 14:13:16 -0400
From: "The Parent Trap" <ParentTrap@media.mit.edu>
To: parent@work.com

Today, someone in your house watched Bill Nye: The Science Guy. This episode dealt with forests.

Your house watched the first 17 minutes of the program, so you saw:
1) 1/3 of all the land on Earth is covered by forests.
2) Forests are like buildings. They have four levels including the canopy, understory, floor, and subfloor.
3) You can determine the age of a tree by counting the rings in a cross section of the trunk.
4) The energy and life cycles in a forest are effected by the greenhouse effect, global warming, and how decomposers turn dead stuff into soil and nutrients for the forest to grow in.
5) A member of the logging industry explaining about the variety of things in the world that come from the forest. Chairs, doors, and many other things need wood to exist.

In the last 08 minutes, you missed:
1) Different kinds of forests are found in different parts of the world.
2) A biologist discussing why she studies the forest canopy. We know a lot about the forest floor and subfloor, but not as much about the very top. The biologist explained how she looks at treetops to discover how energy flows.
3) How forest fires help to renew the forest ecosystem.

Here are some questions you may want to ask your family when you talk about today's show:
1) How do scientists know that each ring on a tree corresponds to a year? How were they able to discover this?
2) Why don't trees grow as tall in your neighborhood as they do in forests? What features of the forest differ from your town?
3) If you do today's experiment, what conclusions can you draw from the results? Why do you think we have to test multiple conditions?

If you need additional information and/or want to see clips from the show, go to http://www.billnye.tv/forests/your-family-profile.htm.

Hope you tune in tomorrow!

Scientifically yours,
Bill Nye

At work, a parent receives this email and knows that their child learned something about forests today. In other words, the email message acts like a progress report that a child would receive in school. It informs parents about the lessons and content that their children are exposed to during television viewing. But, more than that, it provides questions and strategies that go beyond the content of the program and informs parents about pedagogical knowledge and inquiry strategies. For instance, the parent knows that their child learned how to tell the age of a tree. Bill Nye's "Forests" program, however, does not ask how scientists know that one ring on a tree equals one year in age. Upon arriving home, the parent might ask, "How do you think scientists figured out

that one ring on a tree equals one year?" Questions like this are included in email messages to extend content and encourage parents and children to engage in critical inquiry and reflection.

2.2 Email Generation

To generate this email, the "television's" software unfolds justifications embedded within the show and records what portions are seen and missed. The email message explicitly informs the parent about the issues that their children saw and other learning opportunities that may have been missed because the channel was changed or the television turned off. In addition to listing the issues or lessons presented in the show, it also suggests questions that parents can ask their children. The purpose of these questions is to encourage conversations. Since parents often lack strategies for developing explanatory and descriptive commentary (Desmond et al., 1990), these prompts try to model question-asking and inquiry strategies for them (Collins & Stevens, 1982; van Zee & Minstrell, 1997b). That is, the questions are based on inquiry strategies that I hope parents will learn by example.

Finally, a link to a website is provided where parents can view video clips associated with the information provided in the email (see Figure 2.1). This not only contextualizes the annotations, but it also gives parents who can't co-view television with their children the opportunity to see what their children watched.

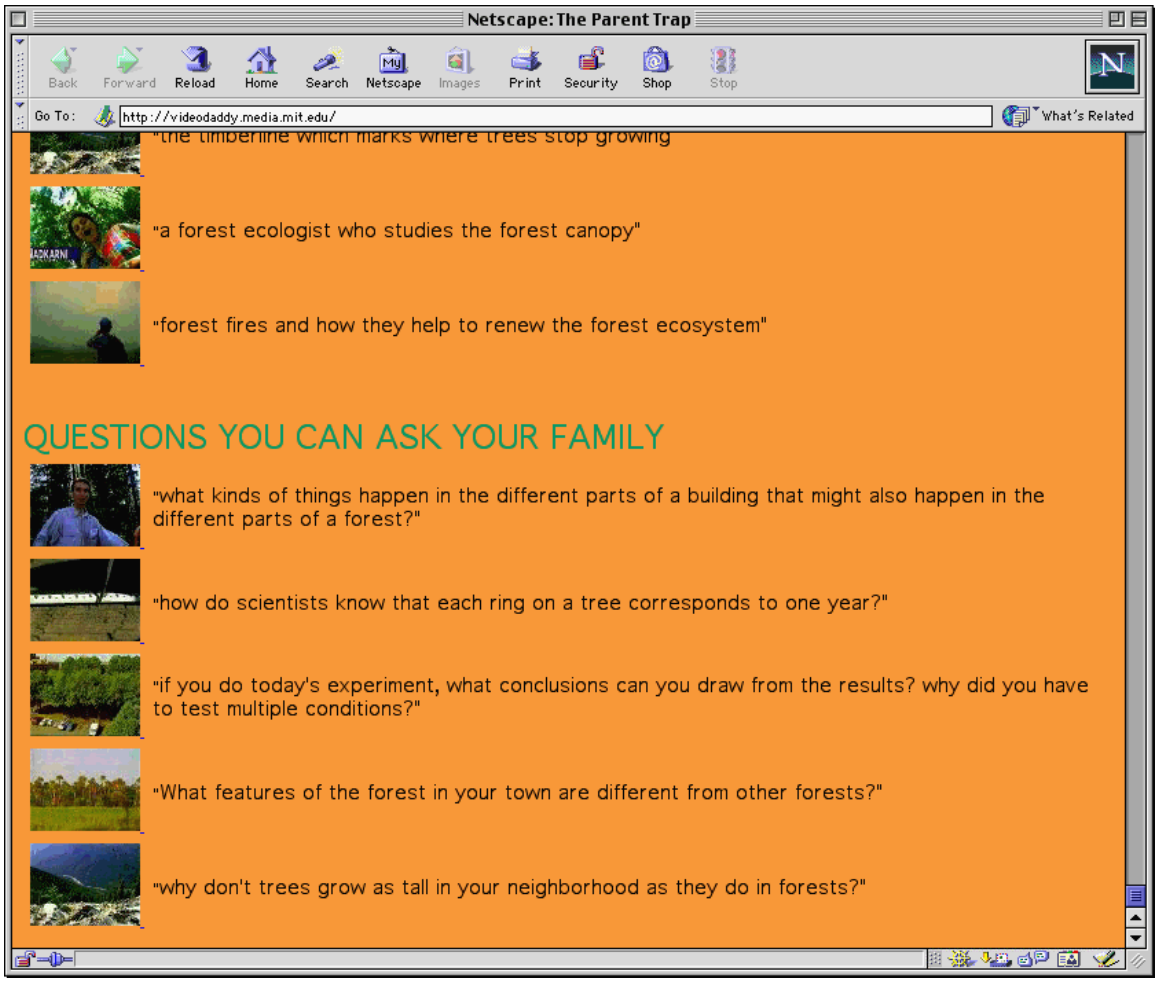

Figure 2.1 The Parent Trap website listing "Issues", "Questions", and their related scenes from the Forests episode of Bill Nye: The Science Guy.

2.3 Annotating Television

A set-top box hooked up to a television can communicate whether the television is turned on or off and can identify what program is playing. It can also store email addresses so it knows where to send messages. Our "television" also knows how to read digital justification structures that are embedded into children's programming. Each episode of Bill Nye: The Science Guy, for example, has a layer of metadata encoded into the video stream that justifies how and why content elements have been included in the program.

Behind the scenes, a content indexer uses software annotation tools to include justifications in the television program. The Parent Trap tools currently let the indexer browse and annotate

video (see Figure 2.2). When he is ready to mark a scene, he can select it by clicking on a "Mark this scene" button. Every time a scene is marked, the system prompts the indexer to enter information about the content design of that scene. For example, he is asked to describe the issue being presented, how and why that issue is represented, and whether there are other ways to explain or elaborate on the issue. There is also a feature to add new types of annotations.

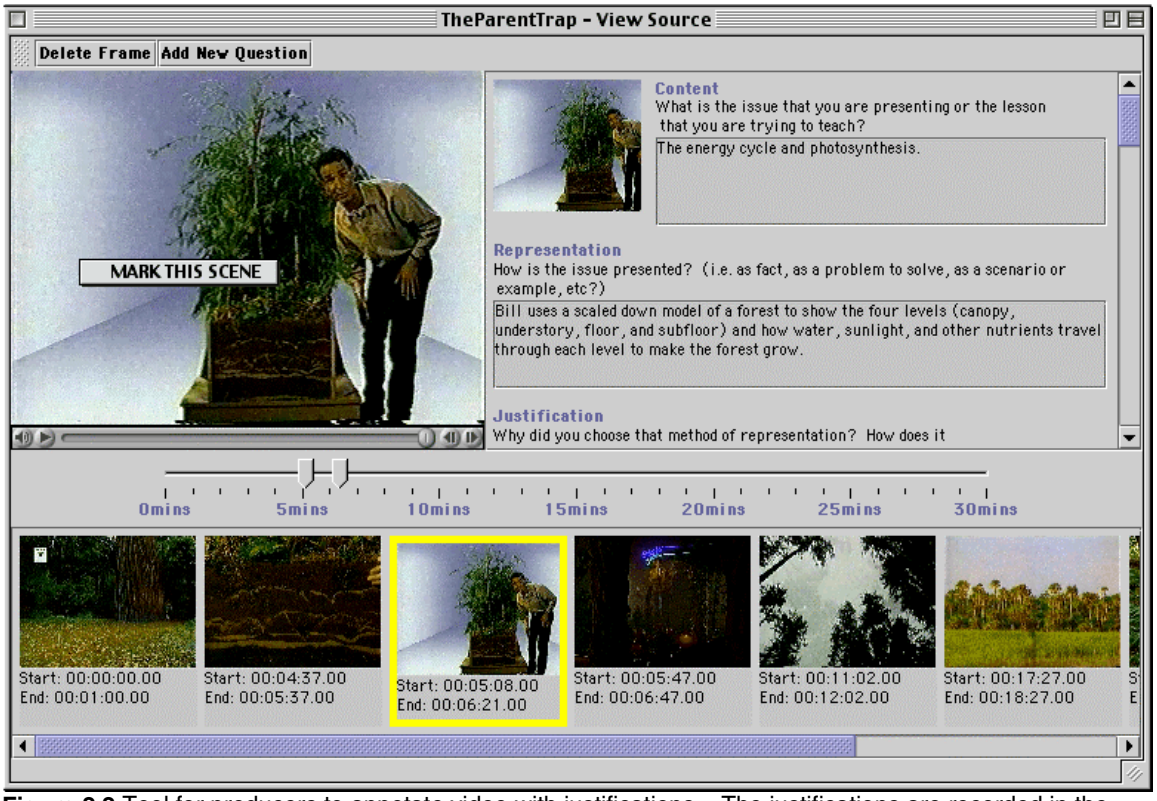

Figure 2.2 Tool for producers to annotate video with justifications. The justifications are recorded in the upper right panel of the screen. Questions guide producers through explaining the educational value of the show's content.

A separate "parser" application eventually reads these justifications and creates and delivers email messages to parents based on the annotations.

Ideally, justifications for television content should be written before a show has completed production (i.e., during the script writing process). In other words, the show should be based on, or designed around some defined purpose instead deriving educational goals after the fact. Certain educational programs, like Bill Nye: The Science Guy, engage teams of scientists and

educators to design the content (i.e., describe educational objectives, pedagogical methods, and content justifications) for each episode of a television program. Stories are written based on this information, but unfortunately, the content design is not revealed to anyone beyond the scriptwriters. With the Parent Trap, producers can embed content designs into a television program and make them accessible to teachers, parents, and children. As a result, parents get additional information about a television program that may help them guide conversations with their children.

Children can be provided with similar questions to challenge their friends and parents. For example, another scenario might involve the child getting a similar email message in which they are given suggestions for questions to ask their parents. This type of message might encourage children to further question the information they see on television and discover other ways to think about and explore the content. They might also receive additional information about websites to visit, books to read, or activities to do that relate to the lessons presented in the program. This additional information can be localized to their communities and might also suggest nearby places to visit that relate to the show they just watched.

In short, the system tries to help children learn from television by modeling conversation and question-asking strategies for parents and providing content development guidelines for producers. In the next chapter, I'll explain how I arrived at this design by giving my own design rationale and theory behind the implementation.

3 Theory and Research Rationale

In this chapter, I explain the assumptions that led to The Parent Trap, including regulations for educational television and reforms in classroom learning. Curriculum materials help teachers scaffold and structure content to lead activities and discussions in classrooms. We can pull some of these content-structuring methods from education into television viewing so parents can lead their children in activities and discussions at home. Before describing how to integrate reforms, lets consider the current state of educational television

3.1 Critiquing Educational Television

In 1990, the United States Congress passed the Children's Television Act (CTA) ordering the Federal Communications Commission (FCC) to require educational programming for children as part of the public-service component of all television station licenses. The CTA establishes a set of requirements for broadcasters to increase the amount of airtime dedicated to educational programming. It also defines educational television as "programming that furthers the positive development of children 16 years of age and under in any respect, including the child's intellectual/cognitive or social/emotional needs" (Federal Communications Commission, 1996, p. 29). This definition leaves ample room for interpretation by broadcasters, allowing them to claim that any program of their choosing is "educational" (Federal Communications Commission, 1996). The breadth of the CTA's definition and the lack of criteria for determining whether a program is "specifically designed" to be educational and informational prompted the FCC to revise their requirements for core educational programming in order to strengthen their enforcement of the CTA. In these revised requirements, the FCC adopts new proposals to provide information to the public and provides processing guidelines to broadcasters about how to comply with the CTA.

The revised Children's Television Act establishes the following requirements (Federal Communications Commission, 1996, p. 89):

1) The program must serve the educational and informational needs of children ages 16 and under;
2) The program must be aired between the hours of 7:00 a.m. and 10:00 p.m.;
3) The program must be a regularly scheduled weekly program;
4) The program must be at least 30 minutes in length;
5) The educational and informational objective of the program and the target child audience must be specified in writing in the broadcaster's Children's Television Programming Report; and
6) Instructions for listing the program as educational/informational, including an indication of the age group for which the program is intended, must be provided to publishers of program guides.

The first requirement is neither explicit nor detailed. What does it mean to "serve the educational and informational needs of children"? The CTA gives no further explanation of what the educational and informational needs of children are, nor do they provide guidelines for how to meet those needs. The rest of the requirements deal only with program scheduling and labeling. None of these requirements explicitly ask how and why the content of a program is educational or informational.

Another example of the loose nature of the CTA regulations can be seen in the FCC approved Children's Television Programming Report shown in Figure 3.1.

Title of Program #3: **BILL NYE SCIENCE GUY**			Origination **Syndicated**
Days/Times Program Regularly Scheduled:	Total times to be aired	Length of Program	Age of Target Child Audience:
Mondays 7 am	**13**	**30** (minutes)	from **6** to **11** (years)
Describe the educational and informational objective of the program and how it meets the definition of Core Programming. **The MTV like show uses humor and imagination to spark kids interest in science. Bill Nye uses high energy and excitement to help make the most complex science questions easily understood.**			

Figure 3.1 Entry from FCC Form 398, the Children's Television Programming Report. This form is meant to describe information about the program with respect to its educational and informational objective and requirements.

The excerpt illustrates how sparse these forms are and how inadequate the information is for justifying educational content. For example, the educational/informational description gives no information about what pedagogical strategies are used in the program. Humor, imagination, high energy, and excitement are good qualities to have in a children's television program, but they do not describe how or why a program is educational. That is, these say nothing about the actual content of the program.

In addition to explaining how a television show meets the CTA's requirements, the children's television programming reports must describe the educational objectives of the program. Unfortunately, these regulations lack strong suggestions or guidelines for television producers about what constitutes "educational". This can be seen when looking through the reports. The following is an excerpt from a report filed for Bill Nye: The Science Guy[1]:

> *Scientist Bill Nye educates, informs and entertains kids as he introduces them to the intricate makeup of the world around us. Amphibians, probability, deserts, the heart, magnetism, atoms, ocean exploration, marine mammals, biodiversity, evolution, nutrition, planets and moons, and the eyeball are the topics that were covered from January 1-March 31, 1998. This program is specifically designed to further the educational and informational needs of children, has educating and informing children as a significant*

[1] Additional examples of these reports are available from the FCC's Children's Television website at http://svartifoss.fcc.gov:8080/prod/kidvid/prod/query1.htm.

purpose and otherwise meets the definition of Core Programming as specified in the Commission's rules.

While this gives an overview of three months worth of content, it does not provide specific information for how and why each episode is structured to educate children. We do not see how the program is designed to further the educational and informational needs of children. Nor do we see obvious relationships between the topics listed, why these issues are important children, or how we can engage children to think more about the issues. These types of insights into the content of an educational program might be useful when trying to structure conversations or other learning exercises. An example of a more detailed description might look like this:

Geared toward the middle school aged children, this half hour special teaches fairly sophisticated scientific concepts encountered in everyday life in a simple, easy to understand, entertaining format. "Experiments" are conducted that demonstrate the scientific method, which aids in the development of logical and sequential thinking and inductive and deductive reasoning. Viewers are encouraged to question and speculate on how things work and why things happen and apply their knowledge to everyday life.

This overview gives a better idea of how the show is meant to be educational since it describes that scientific experiments are used to aid critical thinking and reasoning. A better overview might even give a description of *how* experiments aid learning. For example, "experiments show how to generate hypotheses and test multiple conditions, teaching children to recognize misconceptions in their understanding and support or refute their hypotheses with evidence and justifiable arguments." To arrive at a description like this requires guidelines that focus on a show's content, not just it's scheduling.

There are standards that try to regulate educational effectiveness based on content. However, they still end up stressing a program's form rather than how and why content is developed and

considered educational. The Annenberg Public Policy Center, for instance, outlines four criteria for evaluating the strength of children's educational programming (Jordan, 1998; Jordan & Woodward, 1997; Schmitt, 1999).

1) *Lesson clarity:* Is the lesson clearly laid out so that the target audience can easily comprehend it? Is the message explicitly conveyed?
2) *Lesson salience:* Is the lesson consistently conveyed throughout the program? Is it an integral element of the program as a whole? Does the program give multiple viewpoints and examples for a given issue so that it might be understood under many different circumstances?
3) *Lesson involvement:* Is the lesson presented in such a way that it is engaging and challenging for the target audience? Can the audience relate to the characters portrayed in the program? Is the lesson at the right experience level for the audience?
4) *Lesson applicability:* Is the lesson conveyed in such a way that the target audience can see its usefulness in their own lives? Is the lesson realistically applicable in the audience members' lives.

Some of these criteria seem to be more about how the lesson is framed within a story rather than about the structure or rationale of the lesson's content. Such regulations often result in television programs with high production standards receiving strong educational ratings even though they don't necessarily benefit viewers. In other words, programs end up being well structured and produced without necessarily having strong educational content (i.e., are the viewers being taught anything?). Additionally, these guidelines are more evaluative than prescriptive. That is, they help producers evaluate the quality of programs, but they lack criteria that producers might need during the design and production process. It is *during* this process, and even before, at the program's conception, when it is crucial for content to be questioned and justified.

Unfortunately, both the CTA and the Annenberg regulations lack guidelines for content development. They ask producers to create educational content without providing instruction on how to structure or integrate pedagogy into a program. Guidelines for producing educational television that emphasize content instead of access might increase the amount of quality programming for children. If producers can begin reflecting on their use of content, they may become better equipped to communicate educational intentions to parents and children. With this information, parents can play a large role in mediating television viewing.

Parent interest and involvement with children's learning has positive effects on achievement and motivation (Catsambis & Garland, 1997; Connors & Epstein, 1995; Epstein, 1992. To take advantage of these effects, we can model conversations between parents and children around television viewing. However, we must recognize that the core issue for children's television is not scheduling, but whether the proper educational interventions are being used with television. These interventions can be improved by remembering that television is a social medium. If I can influence parent/child communication, then perhaps television can become a more powerful tool for learning.

3.2 Structuring Inquiry

There are published suggestions for parents on "how to improve television viewing" (Corporation for Public Broadcasting, 1988; Couch, 1995; Huston et al., 1992). These, however, only contain generic recommendations for action. Suggestions such as "set your child's viewing schedule" and "get involved" are disconnected from the content or pedagogical strategies, leaving parents to ask, "Get involved how?"

One way to "get involved" is for parents to watch programs with their children and converse about the content of the shows. When children converse with parents or older siblings during television viewing, they often demonstrate significant leaps in their understanding of the content (Collins, Sobol, & Westby, 1981; Haefner & Wartella, 1987; Huston et al., 1992; Salomon, 1977). In some

cases, conversations can provide concrete stimulation or heightened attention to television content (Dorr et al. 1989). Mediation by a parent or older sibling can also assist children in making sense of and evaluating content (Dorr & Rabin, 1995; Salomon, 1977).

Since television is a social activity, it is likely that parents and children will often have conversations around a television program (Dorr & Rabin, 1995; Kubey, 1994; Kubey & Csikszentmihalyi, 1990). Despite large amounts of co-viewing (i.e., parents and children watching television together), it is less frequent for these conversations to include questions, commentary, explanations, or feedback before, during, or after television viewing (Desmond, Singer, & Singer, 1990; Dorr & Rabin, 1995; Wright, St. Peters, & Huston, 1990). Instead, the types of conversations that typically occur are evaluative (Desmond et al., 1990; Gunter & McAleer, 1997). That is, they usually revolve around whether a program is "good" or "bad" rather than around the issues that were presented in the program. For example, a parent might say, "Those lions are really great!" instead of, "It's interesting to see how lions have strategies for hunting. Maybe we can figure out the hunting patterns of other animals as well." Engaging children in more complex activities (i.e., explanatory or descriptive conversations), such as explaining animal behavior in nature films, can turn a passive viewing experience into a problem-solving task (Smith & Reiser, 1997; Smith & Reiser, 1998). Additionally, to effect conversations, there exists a "need for a strategy on the part of parents to discuss, explain, and to make and enforce rules regarding the use of television in the home (Desmond et al., 1990, p. 303)."

We can adopt and adapt successful classroom strategies to model parent/child interactions in the home. In some classrooms, there is a movement to get students questioning, discussing, and critiquing content, since these activities induce complex knowledge construction and enhanced learning and comprehension (King, 1994; Scardamalia & Bereiter, 1992). Unfortunately, there are still classrooms where students are judged on their abilities to answer questions rather than pose their own or be assessed on their abilities to create or investigate new problems (Scardamalia & Bereiter, 1991). Some teachers, however, use question-asking/problem-solving

strategies and lesson plans to teach and lead discussions around curricular materials (Collins & Stevens, 1982; van Zee & Minstrell, 1997a; van Zee & Minstrell, 1997b). These teachers also encourage students to use the same strategies in their own thinking and learning. Learning in this context means not just getting the facts, but doing something with the facts.

Parents may view learning as the ability to memorize facts or answer questions correctly (Sternberg & Williams, 1995). For example, people often see view science as a collection of facts to be discovered rather than as a changing body of knowledge (Carey, Evans, Honda, Jay, & Unger, 1989; Lederman, 1992; Schauble, Glaser, Duschl, Schulz, & John, 1995; Songer & Linn, 1991). In science, learning happens as much during the problem-solving process (Bruer, 1993) as it does when discovering results. In other words, the approach and assumptions leading up to the results are at least as important as the results themselves. Similarly, the decisions and assumptions made when designing curriculum are important since a designer's intentions can be a key to revealing pedagogical approaches. Knowing these intentions might help parents understand classroom strategies and subsequently increase the positive effects on children's learning (Ball & Cohen, 1996).

I am trying to understand how television might influence parent perceptions of learning. By integrating inquiry structures into educational television content, I hope to model questioning for children and parents so that they might begin to query each other about issues presented in the television program. That is, I want to give parents and children examples of "good" questions from which they can learn to formulate their own. Encouraging parents and children to ask questions will complement and add to the act of simply listening to information.

What do we mean by "good" questions? Sternberg (Sternberg, 1994; Sternberg & Williams, 1995) describes a model of interaction between parents and children that stresses the importance of children learning what questions to ask and how to ask them, rather than knowing the answers to questions. He lists various ways that a mediator, such as a parent or teacher, can respond to

a child's questioning. The different responses illustrate how much follow-up activity is done when children ask questions and how much engagement is required to answer questions. Sternberg's model defines these seven levels:

1) *Rejection of questions (e.g., "Don't bother me now.")*

   At this level, children are discouraged from asking questions. They are taught that asking questions is inappropriate or irritating.

2) *Restatement of questions as responses (e.g., "Because that's the way things happen.")*

   Many parents answer questions by restating them. They don't give any information about the answer to the question or any indication of how one might go about finding the answer. For example, in answer to the question, "why does one ring on a tree equal one year in the tree's age," the response might be, "because the rings tell you how old the tree is." Parents might respond this way when they don't want to be mean by saying, "Be quiet", but also don't want to admit that they don't know the answer.

3) *Admission of ignorance or providing direct responses (e.g., "I don't know.")*

   Here, parents are willing to admit that they don't know the answer to a question, or they answer with as much information as they do know (i.e. "The older a tree gets, the taller it gets, and the wider its trunk.") This category of response can also include reinforcement, where parents reward their children for asking a question (e.g., "Hmmm - that's a good question.") Even if parents don't know the answer to a question, they can use reinforcement to increase the frequency of question asking by children.

4) *Encouragement to seek response through authority (e.g., "You could look in our encyclopedia. Let me get it.")*

   Encouraging children to find answers to questions teaches them facts. Depending on how a parent responds to a question at this level, there are two types of learning that might result. If a parent does the information seeking, the child ends up being a

passive participant in the learning. If, however, the child is told to seek out the information for itself, they end up taking responsibility for their own learning.

5) *Consideration of alternative explanations (e.g., "I don't know, but let's try to figure out some reasons for why this might happen.")*

   This level encourages children to seek answers to questions as well as explore multiple explanations. Responses here should also stress hypothesis formulation so the child realizes that even simple questions can invite alternative explanations.

6) *Consideration of explanations plus a means of evaluating the explanations (e.g., "How could we decide which of these explanations is correct?")*

   Similar to Level 5, parents at this level encourage alternative explanations. They also discuss ways of evaluating the validity of those explanations. Children learn how to generate and test alternative hypotheses.

7) *Consideration of explanations, plus a means of evaluating them, plus follow-through in evaluations (e.g., "Let's try getting some of the information we need in order to decide among these explanations.")*

   In the highest response level, the child is actually encouraged to perform experiments by gathering and testing information to distinguish between various explanations. Children learn how to act upon their thoughts as well as how to think and reflect on their actions.

Asking questions is central to our intelligence and understanding of the world, so asking the right types of open-ended questions (i.e., "why" and "how" questions) encourages critical thought and reflection (King, 1994; Scardamalia & Bereiter, 1992; Schank, 1986; Sternberg & Williams, 1995). If conversations are based on questions, commentary, explanation, and feedback, watching television might change from a relatively passive learning experience to a much more active one. In order to promote more active television interventions, two issues must be addressed: 1) how to help parents effectively engage their children in dialogues that will facilitate learning, and 2) what can be done at the content development level to make that engagement happen.

Curriculum designers create materials that teachers use in classrooms. Similarly, television producers create content that parents can use in homes. Therefore, just as teachers use strategies to structure content in lesson plans, so can parents. That is, with the right tools and pedagogical understanding, we can bring strategies from classrooms into the home and into the context of television viewing. More important than the lesson or content plan itself, however, is the process through which it is created. The motivation for its creation, the structure of the information, and the choices that are made all contribute to the overall design of the content plan. An explicit description of this background information produces a record of reasoning in the design process and supports the recall of decisions and their rationales (Moran & Carroll, 1996). The decisions, therefore, become more understandable and useful for creating future content.

We can use the idea of rationalizing the design process to reform content development strategies in television. A design rationale framework can be used to help producers document how and why content is created. These design rationales can serve as guidelines for developing future content and revealing the rationales to parents may facilitate more informed interactions with their children.

4 System Design and Implementation

In this section, I discuss how The Parent Trap was implemented. I describe its main components: 1) the indexing tools to annotate television programs and 2) a system to deliver information to parents.

4.1 Indexing Framework

Initially, I used episodes of Bill Nye: The Science Guy to think about how content is structured in a children's educational television program. The show has a central theme, which is represented and elaborated upon in various ways throughout the episode. For example, in the "Forests" episode, each scene uses a different context to talk about the four levels of a forest. Bill also uses repetition and experiments to teach concepts. Based on my observations of the design of the show and prior research on questioning, I created a series of questions to help producers reveal the design rationale underlying a television program (i.e., the process producers go through to create the content of a program). For educational television, the design rationale is used to define the pedagogical content and structure of the show.

4.1.1 Design Rationales

Design rationales can be useful for documenting reasoning and capturing decisions made during the creation of an artifact (Moran & Carroll, 1996). Design rationales can be represented in different ways: as a record of design decisions leading to the creation of an artifact, as a set of psychological claims or consequences embodied by an artifact, and as a description of the design space for the artifact (Lee & Lai, 1991). For educational television, we want to combine these representations to describe the process through which content decisions are made, the pedagogical claims or effects of the content, and the content design space. We also want our design rationale to describe how each of these elements connects to each other.

Some design rationale frameworks, such as Questions-Options-Criteria (QOC), have features that make them useful for representing the interconnectivity of their components (MacLean,

1991). For example, the QOC rationale is argument based, meaning that any element can be challenged. By opening arguments up to inspection, flaws can be identified and, based on further justifiable arguments, the representation can be improved. In engineering domains, the QOC framework (MacLean et al., 1991; MacLean, Young, & Moran, 1989) has been used to help people learn about the design process for engineering artifacts (Carey, McKerlie, & Wilson, 1996; Casaday, 1996). Figure 4.1 shows an example of how the design space for a QOC framework would look.

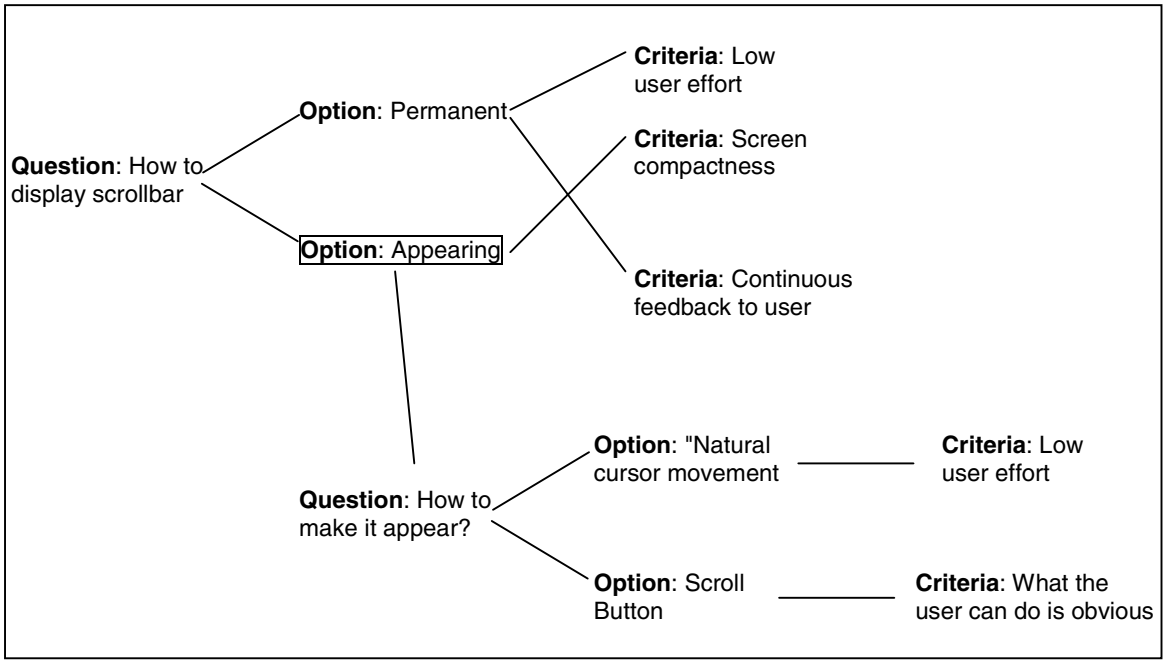

Figure 4.1 QOC representation of the design space for a scrollbar in the Xerox Common Lisp development environment (MacLean et al., 1991).

A variant of QOC can be used to provide explanations and rationales for educational television. The television design rationale that I developed deals with issues, alternatives, and questions (IAQ).

- **Issues.** The issues are the main points of the program, the lesson elements. For example, "the effects of global warming on the environment" may be a key issue within an educational television program. The representation makes unique issues explicit and gives a rationale for why these issues were thought to be important. That is, each issue

can also be linked to a historical record describing why it is considered valuable to the overall program. These historical records can tell us the decisions to choose a piece of content (Burgess-Yakemovic & Conklin, 1990). Such records help us infer and understand the reasons for decisions made (Lee & Lai, 1991).

- **Alternatives.** Issues can be linked to alternatives that encourage inquiry and elaboration of content. The goal here is to present additional information or viewpoints that may have been left out of the program. For instance, in the Bill Nye episode on forests, there is a segment that describes the process of logging and why wood is useful in everyday life. One can imagine that segment being replaced by one where an environmentalist explains the negative effects of logging on the ecosystem. One goal is to help producers articulate alternative stories. These alternatives help learners understand that there are often no "right" answers to the issues posed in television content.
- **Questions.** Each issue or alternative can be associated with a set of questions that extend the program's content. For instance, we can ask what conclusions might be drawn from the results of the experiment conducted in Bill Nye's show, or why it was necessary to test multiple conditions. These questions are the primary way to introduce critical inquiry into television viewing. To guide the development of questions, we can borrow question-asking strategies found in educational research (Brown & Palinscar, 1989; Collins & Stevens, 1982; King, 1994; van Zee & Minstrell, 1997a). Like the alternatives, these questions go beyond the content contained in the television program. Where the alternatives suggest different paths that an argument could follow, the questions push viewers to probe deeper into the presented subject matter.

Like the QOC framework, each element of the IAQ framework is interconnected and can be represented in a similar design space (see Figure 4.2). The representation illustrates the reasoning process underlying the content (Moran & Carroll, 1996). This process consists of identifying issues, which generate alternative issues, which generate questions.

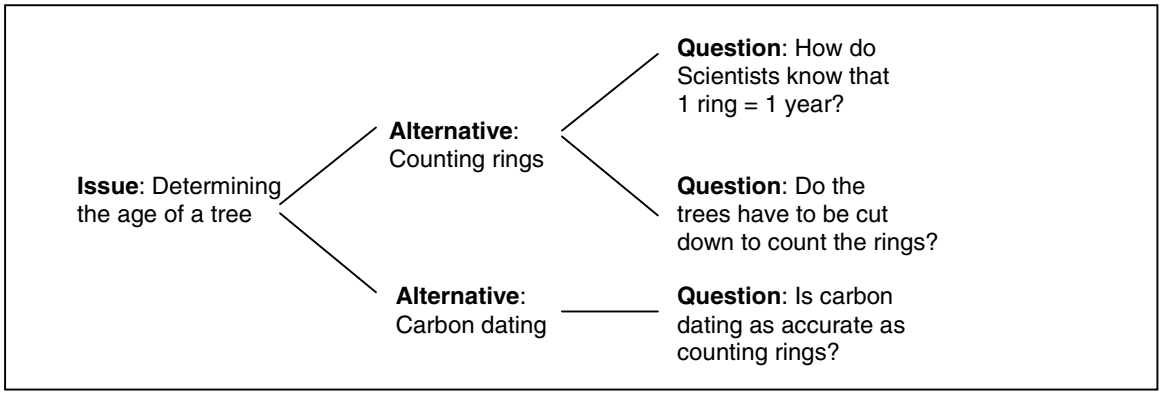

Figure 4.2 Issues - Alternatives - Questions design space for determining the age of a tree.

One purpose for the design rationale framework is to guide producers through the process of justifying educational content. Developing issues, alternatives, and questions can lead producers to reflect on their content decisions and perhaps question the choices they make. It also gives them opportunities to include alternative pieces of content in the underlying design rationale that they may not be able to integrate into the show itself.

The IAQ framework can also be used for other types of shows, such as sitcoms, animated stories, and programs that deal with social or moral issues. For example, shows that contain violence can be annotated with information about conflict resolution methods or reasons why violence is not appropriate behavior.

4.1.2 Questions

The IAQ framework is designed to support a set of questions that relate to both the content and the pedagogical issues of the program. The questions help define the content by describing specific issues and their importance in the program. They also define pedagogical issues by making the methods for representing content explicit. The design rationale and the questions provide a method for producers to reveal their reasons for including content in educational programs. That is, they guide the process of justifying television content. The questions were formulated by borrowing methods from previous research on mechanisms that generate

questions, questions that drive explanation, and questions used in inquiry teaching (Collins & Stevens, 1982; Graesser et al., 1992; King, 1994; Ram, 1991).

For instance, Graesser et al. (1992) identify a taxonomy of inquiries, or cognitive mechanisms, that generate questions. The taxonomy categorizes questions based on meaning rather than form. Questions that begin with "how", for example, can be categorized as either quantification or procedural (*e.g.*, how many donuts are in a baker's dozen? vs. how do you get to the donut shop?) The questions I developed are categorized similarly by the type of information they try to elicit. They also seek explanations and other questions as answers. Responses should justify the content of a program. In other words, they should reveal the lessons being taught in the television show and how those lessons are meant to be educational.

There are six types of questions that guide producers through justifying content. They include content, representation, justification, inquiry, explanation, and elaboration. The first three categories are concerned mainly with issues while the last three categories focus on alternatives and questions. The content, representation, and justification questions try to get producers to explain their reasons for choosing a specific piece of content and for presenting it the way they do. The inquiry, explanation, and elaboration questions try to help producers think about misconceptions that viewers might have and alternative viewpoints for the issues they are presenting.

Content: *What is the issue that you are presenting or the lesson that you are trying to teach?*

This question asks for the main issue being presented. It is important to establish what the producer is trying to convey to the audience. If a specific lesson is being taught or an issue is being presented, it must be made clear here. Bill Nye: The Science Guy, for example, contains a segment called "Way Cool Scientist" showcasing scientists in the

field and the things they study. In the forests episode of Bill Nye's show, the issue is a forest ecologist talking about how she studies the canopy, or top level, of the forest.

Representation: *How is the issue presented? (e.g. as fact, as a problem to solve, as a scenario, as a demonstration, etc…)*

Representation is important because it can color the way a piece of information is perceived or learned. Representing a topic or principle verbally might not work as well as giving a demonstration. For example, an ecologist shows how she ascends the forest levels to study the canopy at the top. This demonstration provides a more illustrative description of how she gets to the top of the forest than a verbal description might.

Justification: *Why did you choose that method of representation? How does it enhance the value of the content?*

Television producers make many decisions as they assemble content. This question asks them to reveal that process to explain why they chose a particular piece of content over another, as well as why it was represented in a specific way over another. A real world demonstration of how a forest ecologist conducts her field research, for example, illustrates her job better than a sit down interview might.

Inquiry: *What conflicts or contradictions can you introduce to initiate inquiry about the issue or its alternatives?*

We want television viewers to think critically about what they're watching. Introducing a conflicting or contradictory issue might cause a person to question what he or she is viewing. By integrating an inquiry structure into this system, I hope to model questioning for children and parents so they might begin to query each other about issues presented in the television program. For example, why doesn't the forest ecologist talk about how she conducts research in a lab? Does she only work in the field? These questions are interesting because they explore alternative issues that may not be covered in the show.

Explanation: *Are any unusual facts or events presented that require explanation? What questions can you ask to reveal explanations?*

This category prompts viewers to try to recognize and question anomalies, or unusual elements, in television content. Additionally, it encourages parents and children to ask explanatory or reflective questions to explain these anomalies. Asking questions can complement and add to the act of simply listening to information. For example, the forest ecologist says that she only studies the canopy of the forest. Since the ecosystem is comprised of all levels of the forest, how can her research be complete, accurate, and understandable if she only studies one level?

Elaboration: *What questions can you ask to elaborate on the issues being presented and the lessons being taught?*

Here, I urge viewers to go beyond the content presented in the television program. By extending the content to "real life" (i.e. events happening in and around the parent and children's world) parents and children will gain a better understanding of the information presented as well as the knowledge of how to discover information in the future. A question here might be, "How does studying what happens at the canopy level help you understand the energy and life cycles of the forest?"

Users can also make up their own categories and questions allowing some freedom in case there are elements of important information missing in the initial set of questions.

The question categories act as primitives in the IAQ framework and are later used to tag scenes in a television program for annotation. Figure 4.3 shows how the questions are formally represented within the system framework.

```
<?xml version="1.0" ?>
<!-- Question Grid-->
<!-- Tamara Lackner-->
<!-- March 9, 2000-->

<document>

    <CONTENT>What is the issue that you are presenting or the lesson
    that you are trying to teach?</CONTENT>

    <REPRESENTATION>How is the issue presented? (i.e. as fact, as a
    problem to solve, as a scenario or example, etc…)</REPRESENTATION>

    <JUSTIFICATION>Why did you choose that method of representation?
    How does it enhance the value of the content?</JUSTIFICATION>

    <INQUIRY>What conflicts or contradictions can you introduce to
    initiate inquiry about the issue or its alternatives?</INQUIRY>

    <EXPLANATION>Are any unusual facts or events presented that require
    explanation? What questions can you ask to reveal
    explanations?</EXPLANATION>

    <ELABORATION>What questions can you ask to elaborate on issues
    being presented and lessons being taught?</ELABORATION>

</document>
```

Figure 4.3 Representation of questions to reveal content justifications in educational television.

4.1.3 Extensible Markup Language (XML)

Questions are linked to video segments through a markup language defined in XML (Extensible Markup Language). XML is a metalanguage that lets you customize all of the features of the language (World Wide Web Consortium, 1998). It is useful because it encodes structure by allowing designers to articulate the semantics behind a document. For example, if I want to tag a body of text with all references to horses, I can define a tag called "horses" instead of using the standard "body" tag found in HTML documents. Once horses are identified within documents, additional programs can use the semantic markers to generate various applications around horses. With XML, I can create a new markup language for educational television. The tags in this case simply describe the pedagogical category (also referred to as "domain"), a question related to that category, and the annotations provided by the producer or content developer (also referred to as "answer").

Figure 4.4 shows XML annotations from a marked-up scene of Bill Nye: The Science Guy. The document contains a series of XML frames, or selections, each of which holds tags describing the

domain, question, and answer. The selection tag also has attributes marking the start and end frames of the scene.

```
<?xml version="1.0" ?>
<document movie="/videodaddy/Users/Tammy/TheParentTrap/forests.mov">
  <SELECTION STARTFRAME="186600" ENDFRAME="246600">
    <DOMAIN>Content</DOMAIN>
<QUESTION>What is the issue that you are presenting or the lesson that you are trying to
teach?</QUESTION>
<ANSWER>Determining the age of a tree by counting the rings in a cross section of its trunk.</ANSWER>
  </SELECTION>
  <SELECTION STARTFRAME="186600" ENDFRAME="246600">
    <DOMAIN>Representation</DOMAIN>
<QUESTION>How is the issue presented? (i.e. as fact, as a problem to solve, as a scenario or example,
etc?)</QUESTION>
<ANSWER>Bill is lying on top of a cross section of a tree trunk counting the rings. He shows how he counts
each ring on the tree to figure out its age.</ANSWER>
  </SELECTION>
  <SELECTION STARTFRAME="186600" ENDFRAME="246600">
    <DOMAIN>Justification</DOMAIN>
<QUESTION>Why did you choose that method of representation? How does it enhance the value of the
content?</QUESTION>
<ANSWER>Kids can easily transfer the activity that they see on television to their "world". You can imagine
them going out in their neighborhood and finding a tree stump to count the rings on.</ANSWER>
  </SELECTION>
  <SELECTION STARTFRAME="186600" ENDFRAME="246600">
    <DOMAIN>Inquiry</DOMAIN>
<QUESTION>What conflicts or contradictions can you introduce to initiate inquiry about the issue or its
alternatives?</QUESTION>
<ANSWER>What if the tree isn't cut down? How can you tell the age of a tree if you can't see the cross section
to count the rings?</ANSWER>
  </SELECTION>
  <SELECTION STARTFRAME="186600" ENDFRAME="246600">
    <DOMAIN>Explanation</DOMAIN>
<QUESTION>Are any unusual facts or events presented that require explanation? What questions can you ask
to reveal explanations?</QUESTION>
<ANSWER>How do scientists know that one ring on a tree equals one year? How did they discover
that?</ANSWER>
  </SELECTION>
  <SELECTION STARTFRAME="186600" ENDFRAME="246600">
    <DOMAIN>Elaboration</DOMAIN>
<QUESTION>What questions can you ask to elaborate on issues being presented and lessons being
taught?</QUESTION>
        <ANSWER>Why is knowing the age of a tree important?</ANSWER>
  </SELECTION>
</document>
```

Figure 4.4 Structure of a justification structure generated by the producer application. Each selection is associated with a specific scene, marked with start and end frame times. The structure documents the scene's domain, or question category, along with each domain's related question and answer.

The following section describes the tool that producer's use to create annotations for an educational television program.

4.2 Tools for producers

Rather than making producers write XML code, I created an annotation tool to let them browse video and mark relevant segments — once sequences are annotated, the program generates the XML for the producers. The application is written in Java, using Apple Computer's QuickTime for Java to handle video display and IBM's XML parser for Java to generate the justification structures. To facilitate annotation, the design rationale framework was applied to this application. That is, the justification frameworks were implemented within an application that allows users to step through a video, select and mark scenes, and provide justifications for the selected content.

There are three main interface components in this application:

- **Video screen**: For the purposes of this project, television programs were digitized and displayed as QuickTime video. Within the application, producers can play and step through a show. When they want to mark a scene, they can click on the video to bring up a "Mark this scene" button. Once pressed, an icon representing that scene shows up in the timeline overview.
- **Timeline overview:** This component displays all of the annotated scenes in chronological order. An icon that includes an image of the first frame in the scene as well as the start and end frame times represents each scene. A slider allows users to manipulate the duration of a selected scene. Changes in the start frame time, when dragging the "in" slider, are reflected in the video screen, timeline icon, and annotation workspace thumbnail image. Once a scene is selected and the duration is set, a user can click on the icon to highlight that scene and bring up the annotation workspace.
- **Annotation workspace area:** The workspace area contains a thumbnail image of the first frame in the marked scene. It also lists question categories, questions, and editable text areas where users can enter their annotations. A toolbar button offers the ability to add a new question. When this option is selected, users are prompted to enter a new

category name, a new question, and an answer to the question. Another toolbar button allows users to delete whole scenes.

Upon saving the annotations, all of the information in the workspace area is placed in an XML file. Saved XML files can also be reloaded into the application for viewing or editing.

Figure 4.5 shows the producer application interface as well as how the justification framework can be connected around a particular video segment. Laying out information in this way makes tacit assumptions about educational content explicit to producers. The justifications not only help parents and children engage in reflection, but they may also facilitate reflection for producers, helping them become aware of implicit decisions made during production.

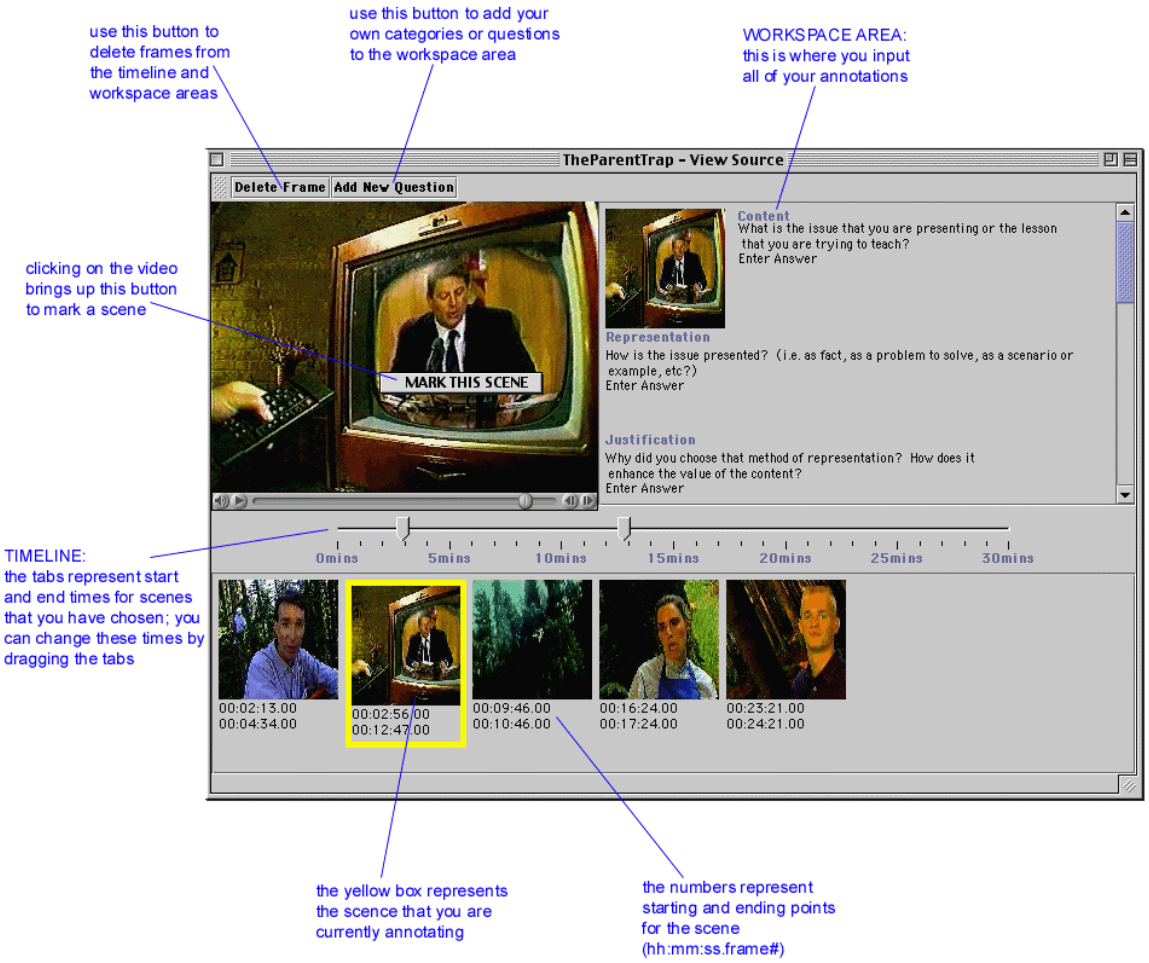

Figure 4.5 Indexing tool interface with descriptions of functionality.

4.3 Tools for parents

A second application takes the producers' annotations and delivers them in a meaningful way to parents. This is a Java application with QuickTime support for playing a digitized television show. An XML parser is also used to read and summarize the annotations created by producers. Annotations are parsed based on their tags. For example, if a "DOMAIN" tag contains "Content" as it's body of text, then the text in the body of the "ANSWER" tag for that annotated scene is extracted and output into the email message. The application also keeps track of the timecodes for annotated scenes so that the email message will be formatted correctly and so that the webpage will contain the correct video clips from the program.

For the purposes of prototyping the experience, we pretend that the computer is a television. In other words, the application appears as nothing more than a television program on a computer screen. The underlying mechanism of the application keeps track of when the television program is started and stopped. Once the show ends or the child stops watching, the application sends an email to a parent containing a summary of what the child watched (see Figure 4.6). The summary includes the issues that were covered in the show, suggestions for questions that parents can ask their kids, and a link to a webpage with video clips and additional information associated with each of the issues.

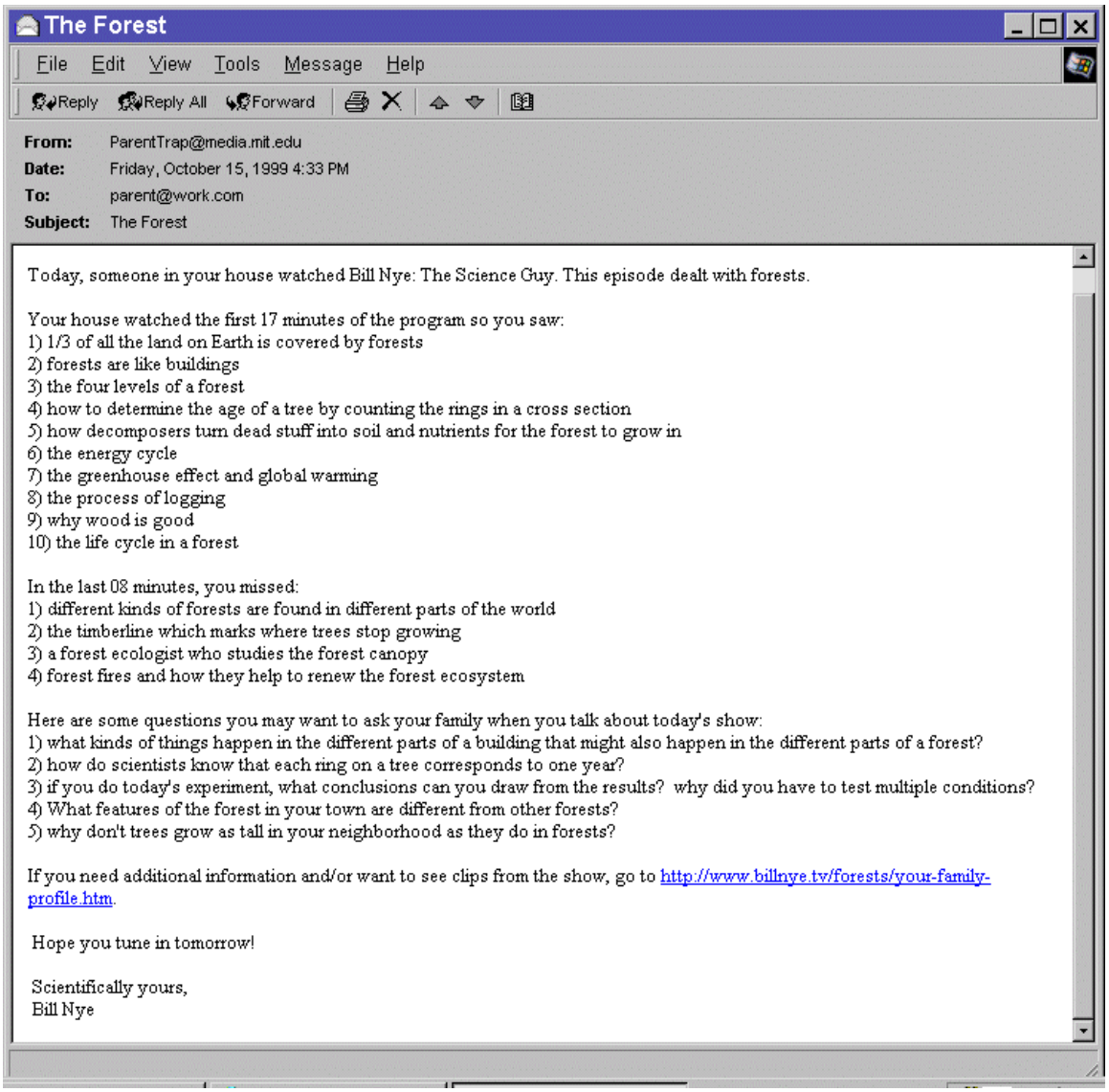

Figure 4.6 Email message delivered to parents after someone in their house watched an episode of Bill Nye: The Science Guy.

The contents of the three sections of the email message are derived from the XML file generated by the producer's application. The "parent application" keeps track of what portion of the television show was watched and what was missed. The first section of the email message, issues watched, is a list of annotations from the "content" domain for every scene that was viewed. Similarly, the second section of the email message, issues missed, is a list of the "content" annotations from the scenes that were not viewed. If annotations in the "content" domain end in question marks, they are listed in the "questions to ask" section of the email. This

section also lists all the remaining annotations from the XML document that end in question marks.

The website is dynamically generated from the email message that is delivered to parents (see Figure 4.7). Unlike the email, however, it does not make a distinction between the part of the show that was seen and the part that was missed. It lists the issues covered in the entire program and the questions that parents might want to ask their children. It also displays links to associated clips of the television show for each issue and question listed. This allows parents who may not have seen the show to put the annotations in context with the program.

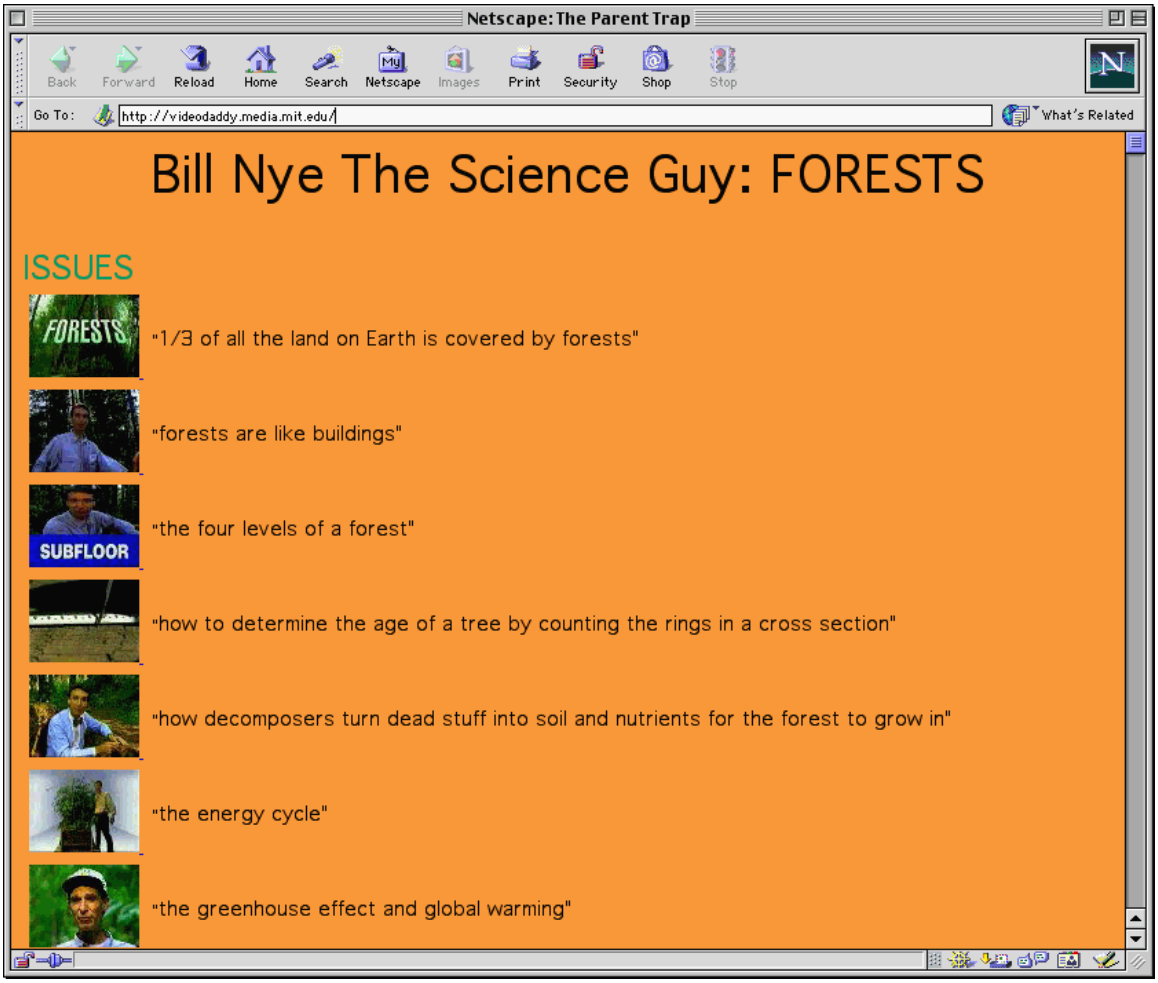

Figure 4.7 Webpage that parents receive, along with email messages, about the television program that their child just watched.

5 Evaluation

To understand how justification structures affect the value of educational content production, I deployed annotation systems to audiences for evaluation. In this first iteration of software development, issues revolved around the technological implementation of the system and the creation of justification guidelines for producers.

System development is continuing to progress through several stages. The first stage, whose evaluation is described here, involves developing a theory of justification for producers to describe the content and rationale behind educational television programming. The next two stages of development will determine whether content justifications impact parent-child interactions and learning as well as whether they change how producers think about the content and design of educational television.

5.1 Assessing the Value of Justifications

I need to develop a vocabulary that successfully describes educational intentions. The IAQ framework is the backbone of the indexing vocabulary while the question categories are the "primitives" that can be used to tag frames of the video with justifications. In determining how to structure this vocabulary and indexing system, several questions arose:

1) *What pedagogical and content issues need to be represented to describe the educational benefits of children's television?* We want to determine what the producers need to reveal about the content of their programs in order to gain a good understanding of specific content development decisions. For example, why was the choice made to include one perspective or piece of content over another?
2) *How can these features be communicated to producers to influence their design and production decisions?* To make producers aware of their design process and decisions, we need to provide them with guidelines. These guidelines outline what

pedagogical issues and inquiry strategies should be considered when developing educational content.

3) *What types of tools are needed to represent and encode these justifications into television broadcasts?* It's not enough to tell producers how to think about content. A mechanism, or tool, to implement the guideline structure is needed to easily and consistently annotate television content.

For this evaluation, I want to determine whether the questions developed to guide content justification are accurate and adequate enough to reveal the methodology underlying educational television programs. That is, will the design rationale lead broadcasters to reveal or discover the pedagogy behind the content in their programs? Before going to actual producers, we want to see what will happen when educational technologists tried to use the tools. To do this, we enlist 16 students in an MIT course on educational technology to see how they use the tools to think about justifying television content. The students are from MIT and the Harvard School of Education and are interested and involved in the development of educational materials

5.2 Testing The Parent Trap

This research makes two claims: a) by revealing the pedagogical rationale behind educational television, producers will be able to better reflect on their methods for content development, and b) given content justifications for educational television, parents will be able to engage in more explanatory conversations with their children.

5.2.1 Participants

To address the first claim, 6 groups of students (16 total participants) evaluated The Parent Trap's annotation tool. The participants were enrolled in an MIT course (MAS.123 Tools for Thought) and included undergraduates and graduates from both Harvard University and MIT. The evaluation of The Parent Trap software was completed as a homework assignment for the course.

5.2.2 Metrics

With this evaluation, I was interested in determining whether the students would successfully annotate their programs. In other words, I wanted to see if the students could justify the content of the programs they chose. In their annotations, I was looking for design rationales (i.e., what content decisions were made and why). I was also interested in whether the software interface was comprehensible and easy to use.

5.2.3 Procedure

Participants were given instructions for completing the evaluation:

1) **Find a television show.** First, pick a show that has "educational/informational" value. You probably want to choose something that is appropriate for children. On the other hand, feel free to use news programs, documentaries, etc., as those have value, and kids do watch them. A 30-minute program would be ideal.
2) **Digitize it.** You'll need to use Apple G4 machines to digitize your television clip. It will take 30 minutes to digitize the video. Once digitized, it will take several hours to compress the video into a useful form.
3) **Annotate it.** The Parent Trap application currently lets you browse your video clip. When you're ready to mark a scene, grab it by clicking on the video itself. When you release, you'll see an icon at the bottom of the screen telling you that the scene has been marked. In the upper right corner of the application interface the system will prompt you to answer a series of questions. Look at these to see what kinds of possible annotation categories there are. Also, we encourage you to add new types of annotations. Basically, the system should tell you the "options" that you have for each frame you mark. In the middle of the screen are two sliders with numbers (corresponding to time). You can use these to select a range of the film. For example, you might want to have a set of annotations apply from 3 minutes 29 seconds to 5 minutes.

4) **Write it up.** Finally, your deliverables. You'll have an annotated program that can be run in our viewer, and we can send lots of mail about television shows. You'll submit the XML file that the program generates as well as the write-up describing your annotation process. What were the important learning issues in the program? How did you think they could be expanded? How did you use the annotation features to "go beyond" the content? Did you add extra annotation categories? What were they and why did you need them? As always, the write-ups help you to reflect on the experience. They also help us design better systems, so we really appreciate you taking time to think about your time with the system and how we can make it better.

The television programs that the students selected included Animal Rescue, Ushuaia, Out of the Box, Nick News, Malcolm in the Middle, and Wishbone. All of these programs, with the exception of Ushuaia, are produced for younger audiences. Ushuaia is a documentary program that showcases various news and adventure stories.

5.2.4 Results

On average, the participants who evaluated The Parent Trap agreed that providing parents with information about the shows that their children watched was a good idea. Acting as television producers, however, they had concerns about both the comprehensibility of the guideline questions and the overall usability of the software.

Comprehension

Several issues arose with respect to the set of questions that "producers" were asked to answer in order to justify educational content. Since the students who evaluated the system didn't actually produce the programs they annotated, some of the questions they answered were said to be unclear. For the "Inquiry" question, students weren't sure how to introduce conflicts or contradictions into the issue presented in the program. Similarly, with the "Representation" questions, students weren't sure how to describe the pedagogical methods that producers were

using. There were no reports of confusion with respect to other questions. However, some students felt that several of the questions and answers were redundant. One student remarked, "a lot of the answers to our questions also tended to overlap-- for example, elaborating on issues learned versus inquiry".

In their analysis of the software, participants also stated that the set of questions was too standard for some television programs. In other words, the questions didn't apply to specific issues presented on an educational program. For instance, hands-on science shows might need explicit labels for “Experiments”. This made it difficult to appropriately index a program with justifications. The classifications of tags for Out of the Box, for example, aren't specific to the program (see Figure 5.1). Shows like this might need more structured labels (i.e., shows with songs might have a “Song” tag that talks about the point of the song).

```
<SELECTION STARTFRAME="118800" ENDFRAME="154800">
  <DOMAIN>Content</DOMAIN>
    <QUESTION>What is the issue that you are presenting or the lesson that you are trying to
    teach?</QUESTION>
    <ANSWER>You can make up your own words to a familiar tune.</ANSWER>
</SELECTION>
<SELECTION STARTFRAME="118800" ENDFRAME="154800">
  <DOMAIN>Representation</DOMAIN>
    <QUESTION>How is the issue presented? (i.e. as fact, as a problem to solve, as a scenario or example,
    etc?)</QUESTION>
    <ANSWER>Vivian remembers a familiar tune, but can't remember the words. Tony suggests that the kids
    make up some new words. The kids sing two different variations of the tune using their own
    words.</ANSWER>
</SELECTION>
<SELECTION STARTFRAME="118800" ENDFRAME="154800">
  <DOMAIN>Justification</DOMAIN>
    <QUESTION>Why did you choose that method of representation? How does it enhance the value of the
    content?</QUESTION>
    <ANSWER>Seeing other children make up their own words to a common tune inspires the viewers to also
    create their own words, and not be intimidated by the act of songwriting.</ANSWER>
</SELECTION>
<SELECTION STARTFRAME="118800" ENDFRAME="154800">
  <DOMAIN>Inquiry</DOMAIN>
    <QUESTION>What conflicts or contradictions can you introduce to initiate inquiry about the issue or its
    alternatives?</QUESTION>
    <ANSWER>Is it right to change the words to a song that someone already wrote? Are there any songs that
    you wouldn't want to change the words to?</ANSWER>
</SELECTION>
<SELECTION STARTFRAME="118800" ENDFRAME="154800">
  <DOMAIN>Explanation</DOMAIN>
    <QUESTION>Are any unusual facts or events presented that require explanation? What questions can you
    ask to reveal explanations?</QUESTION>
    <ANSWER>Don't worry about finding the right words for a song. There is no "right answer." Experiment
    with different versions of your song, and see which ones you like. Try thinking of lots of different things to
    write a song about.</ANSWER>
</SELECTION>
<SELECTION STARTFRAME="118800" ENDFRAME="154800">
  <DOMAIN>Elaboration</DOMAIN>
    <QUESTION>What questions can you ask to elaborate on issues being presented and lessons being
    taught?</QUESTION>
    <ANSWER>Do you and your friends make up new words for songs together? Could you create a song you
    like by changing the words to a song you don't like? What is your favorite song? Is it your favorite song
    because of the tune or the words?</ANSWER>
</SELECTION>
```

Figure 5.1 Annotations from a scene in Out of the Box about making up song lyrics.

Usability

The software requires a fair amount of instruction to use and is still in a prototyping stage. As a result, several participants were somewhat frustrated and confused when evaluating the annotation tool.

The two most frequent concerns with the usability of the software were saving annotations and selecting endpoints for annotated scenes. At the time of evaluation, there was no "Save" function, only "Save As". Consequently, whenever annotations were saved, users had to navigate through several directory structures in order to save their work in the appropriate folder. Also, at the time of evaluation, there was no visual indication of where a scene selection ended. This made it very difficult for participants to set durations (i.e., range from starting frame to ending frame) for their selected scenes. Nevertheless, some students reported the process of setting durations with sliders to be "well designed" and "intuitive".

Email Generation

There was some disappointment expressed about the email that was generated as a result of participants' annotations. Several participants reported that the email took their annotations out of context and might therefore be rendered useless to parents. One student remarked, "What you put in is not what you get out." This student thought that the email message generated from her annotations was too cryptic and placed the annotations out of context (see Figure 5.2).

```
Here are some questions you may want to ask your family when you talk
about today's show:

1) Why are skunks valuable?  Why does musk burn our eyes?
2) How are skunks valuable?  How are skunks good at controlling rodent
   and insect populations?  What makes skunk musk smell?  Why is that
   guy wearing a white suit?  What is that guy carrying?
3) How is the musk dispensed?  How do you get the musk off you?
4) The mechanism of musk spraying could have been elaborated upon. A
   computerized animation of how the nipples on the anus work would
   have been helpful (seeing the skunk's butt doesn't really clue the
   viewer in onto how spraying occurs).  What role do the different
   body parts play in musk spraying?  How do you know when the skunk
   is going to spray?  What effect does the water have on the musk?
   Why does the man run and jump into the water?
5) What are the characteristics of the different kinds of skunks?
```

Figure 5.2 Portion of the email generated from annotations of Animal Rescue.

While students were annotating the program, they could not see how the final product of their work would look. To put their annotations in context, they wanted to see the email being generated as they annotated the program. Since they couldn't, the email was not thought to be

as useful for learning as actually marking up the program. The usefulness of the email messages as well as parents motivation to act on the information in the email was questioned. More active approaches to delivering content justifications were suggested. One suggestion was to display annotations on the television during a program so that additional information would be in context and so parents could discuss issues with their children during viewing. The difficulty with this suggestion is that it implies coviewing, which would either require the parent to be home during the show or to record it for later viewing.

Since the software is still in an early stage of development, links to webpages were not included as part of email messages generated from annotations. Some students requested and were supplied with inactive webpages to include in their written critiques. With the inclusion of webpages, annotations might make more sense and be placed in greater context.

Additional concerns

Several additional questions arose during the annotation process:

- Would producers really take the time to do this? There are doubts that this would be high on a producer's or broadcaster's agenda especially if their program is only marginally educational.
- Should producers be the ones doing the annotating or should it be educators?
- What would these post-viewing conversations look like in reality?
- This system can capture so much interesting information. How could it be given to parents and children in a richer format than email?
- How might children be more active in this process, constructing their own questions and meanings, via the application?

Privacy was also a prevalent issue among all of the participants. Though the software is not intended to be a monitoring device, many students felt that it would act as one for parents. Some students believed that a parent might use the software to monitor what shows their child was

watching in order to regulate viewing habits. Even if the parent's intentions are not to monitor their child, the child might feel that his or her privacy is being invaded anyway.

5.2.5 Discussion

Clearly, this software is still in the prototyping stage. Various revisions to the user interface and the guideline questions must be made to address the concerns raised from this first evaluation. Additional functionality has already been added to the annotation tool, such as a "Save" function and visual indication of a scene's endpoint. The interface is also being revised clarify the annotation process.

We have yet to determine whether it will be more effective to use a general set of questions, or a more specific one. Further evaluations will determine whether questions targeted for specific television programs or domains might elicit more detailed justifications and less confusion and redundancy.

Although there were many valid complaints about the software, students did end up reflecting on the content of the programs they annotated. Even for a program like Malcolm in the Middle, which is considered entertaining and not necessarily educational, participants made critical observations about the content and the types of lessons that children could learn from the show. During a scene where Malcolm is faced with an embarrassing situation, for example, the annotators responded to the "Elaboration" question with "Do you ever feel like you don't get the things that you want? Malcolm says he doesn't care about people that are worse off than him. Do you think that's fair? Malcolm can't change the fact that he's poor. Does he have a responsibility to be loyal to his family and supporting them in this time of need?" Figure 5.3 shows the complete annotations for the scene.

```
<SELECTION STARTFRAME="402000" ENDFRAME="450600">
    <DOMAIN>Content</DOMAIN>
        <QUESTION>What is the issue that you are presenting or the lesson that you are trying to
        teach?</QUESTION>
        <ANSWER>Social Class causing stress</ANSWER>
</SELECTION>
<SELECTION STARTFRAME="402000" ENDFRAME="450600">
    <DOMAIN>Representation</DOMAIN>
        <QUESTION>How is the issue presented? (i.e. as fact, as a problem to solve, as a scenario or
        example, etc?)</QUESTION>
        <ANSWER>A scenario: Malcolm is embarrassed by his "gross" lunch in comparison to the lunch of a
        classmate with more money.</ANSWER>
</SELECTION>
<SELECTION STARTFRAME="402000" ENDFRAME="450600">
    <DOMAIN>Justification</DOMAIN>
        <QUESTION>Why did you choose that method of representation? How does it enhance the value of
        the content?</QUESTION>
        <ANSWER>It gives a reason for Malcolm's stress that is easily understandable by children his
        age.</ANSWER>
</SELECTION>
<SELECTION STARTFRAME="402000" ENDFRAME="450600">
    <DOMAIN>Inquiry</DOMAIN>
        <QUESTION>What conflicts or contradictions can you introduce to initiate inquiry about the issue or
        its alternatives?</QUESTION>
        <ANSWER>Should Malcolm be ashamed of his lunch? Should Malcolm have lied to the girl about
        why he had such a bad lunch? Do you think the girl would have left the table if Malcolm had stayed?
        Would you have left? Does Malcolm have any right to shout at his friend after he leaves the
        table?</ANSWER>
</SELECTION>
<SELECTION STARTFRAME="402000" ENDFRAME="450600">
    <DOMAIN>Explanation</DOMAIN>
        <QUESTION>Are any unusual facts or events presented that require explanation? What questions can
        you ask to reveal explanations?</QUESTION>
        <ANSWER>Why does Malcolm send his friend away when the girl shows up? Why is Malcom's
        friend in a wheelchair, and why does he breathe strangely?</ANSWER>
</SELECTION>
<SELECTION STARTFRAME="402000" ENDFRAME="450600">
    <DOMAIN>Elaboration</DOMAIN>
        <QUESTION>What questions can you ask to elaborate on issues being presented and lessons being
        taught?</QUESTION>
        <ANSWER>Do you ever feel like you don't get the things that you want? Malcolm says he doesn't
        care about people that are worse off than him...do you think that's fair? Malcolm can't change the fact
        that he's poor, does he have a responsibility to be loyal to his family and supporting them in this time of
        need.</ANSWER>
</SELECTION>
```

Figure 5.3 Annotations for a scene from Malcolm in the Middle.

During the annotation process, participants paid more attention to the issues being presented in the various shows and generally felt challenged when trying to justify the content. They were satisfied with the idea of holding producers accountable for claiming that their shows contain educational content. However, these were students acting as producers so their opinions and performance might vary greatly from actual producers who evaluate this software.

6 Conclusion

The Parent Trap gives information to parents to help their children learn. The software delivers messages informing parents about the pedagogical content and structure of the program their child watched. The messages try to reveal and model inquiry strategies so parents can initiate dialogues with their children around television; transforming the television from a passive learning medium into an active learning experience. The email message that parents receive also tries to assist them and their children in thinking critically about the content of the program as well as beyond the content. The types of interactions that occur as a result of the email message will hopefully encourage parents to co-view other programs with their children, using the pedagogical strategies modeled in The Parent Trap.

Some of the strategies modeled in The Parent Trap apply classroom teaching methods and other educational techniques to television. Since question asking benefits learning, we try to structure the tools towards inquiry, modeling question asking and answering techniques. To generate inquiry based information for parents, television producers are given guidelines which ask them to describe why content decisions are made and how alternative viewpoints can be presented. These guidelines hold producers accountable for the educational quality of their shows by asking them to explicitly describe and justify the lessons and pedagogical methods they use to create content.

Annotation guidelines are built around a design rationale framework, which can represent the decision process that leads to content creation. I develop an Issues-Alternatives-Questions (IAQ) design rationale that allows lessons, or main issues, in a program to be extended with alternative issues and questions that elaborate on the content. The IAQ framework is based on a theory of justification, which maintains that having information about the pedagogical knowledge and content structure of an educational television program can facilitate more reflective conversations around that program. Embedding justifications into television programs may also encourage

producers to be more critical of the decisions they make with respect to content creation and design.

An initial evaluation supports the general idea of justifying educational television content. However, these initial tests were conducted with students whose opinions might greatly differ from those of actual television producers and content developers. The evaluation confirms the need for further development and testing of the annotation tools and guidelines. Revisions include refining the set of questions that producers are asked to answer during the annotation process, restructuring and adding functionality to the user interface, and devising alternative, as well as more interactive methods for delivering information to parents.

We can also think about providing teachers with information about program content since they occasionally use television as a source of instructional material. Television stations usually distribute teachers' guides to build lesson plans around content. Replacing the written guides with a digitally delivered framework for learning might be educationally beneficial and very cost effective for both producers and schools. Creating a similar system for children to receive information about television programs is also planned for future development. With such a system, children might be able to receive information about local activities to participate in that relates to programs that they view.

Additional future work will be conducted over the next four years in accordance with a National Science Foundation grant recently awarded for this research. Observational studies in classrooms and homes will determine the types of interactions that occur around television with teachers, parents, and children. The results of these studies will be used to revise the justification guidelines for producers. Education and media professionals will also be consulted to try to understand how our design rationale might benefit content producers. These advisors include David W. Kleeman, Executive Director of the American Center for Children and Media, and Dr. Peggy O'Brien, formerly Vice President for Education at the Corporation for Public

Broadcasting. To determine the utility of the delivered messages, evaluations will be conducted within a local, low-income housing community. Since television is such an accessible medium, alternative message delivery systems that accommodate both literate and non-literate populations will be explored, including providing a toll free telephone number for parents to call or videotapes with information about the television program. Families in the community with children between the ages of 8 and 14 will be provided with digital television infrastructures. Their activities will be followed over time and interviews will be conducted to determine whether the messages generated from television programs change the nature of conversations in homes.

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