Exploring the Second Screen with Dora

Design and Evaluation of a TV Companion Application for Children

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by

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CONTENT

PROBLEM

Television viewing is a popular activity among young children. Children aged 2 to 5 are now spending more than 32 hours a week on average in front of a TV screen. Children aged 6 to 11 watch on average 28 hours per week of TV (McDonough, 2009). These numbers are at an all-time high among young children. Although research has shown negative effects such as decreased academic performance and childhood obesity (Ford, Ward & White, 2012) from excessive TV viewing, not all TV viewing activities are harmful to a child's development. Viewing educational television programs can also be beneficial (Fisch, 2004), positively impacting areas such as literacy (Rice, 1980), mathematics (Fisch, 2003) and problem-solving (Anderson et al., 2000). However, children are often passively consuming the information instead of actively thinking and learning. Therefore, how can we promote active engagement and learning to children during TV viewing?

TV companion applications have been developed for many shows to increase audience engagement, using a second-screen device such as the mobile phone or tablet computers. However these applications are primarily aimed at an adult audience, and there is a gap in the market for age-appropriate products for children. What design issues need to be taken into consideration in developing a second-screen application in an age-appropriate manner for young children?

SOLUTION

The solution proposed is the development of a second-screen application that brings children out of a state of passive consumption and into active participation. The act of watching TV on a larger screen is still preserved, as a secondary tablet device is used to present contextual activities and information related to the TV show being watched. Interaction with these activities will not only actively engage the user with the TV show, but also reinforce the educational aspects of the program. This application would also help determine the viability of creating second-screen content for children, in a user-friendly manner. The long-term goal of the application is to have a positive impact on the cognitive development of young children, while they spend time watching educational television.

Dora the Explorer

Dora the Explorer is the TV show selected as the premise for the second-screen application. The show is a successful animated series and is geared towards boys and girls aged two to six (Bryson, 2012). Each episode in the series follows the central character, 7-year-old Dora Marquez along a quest. She is accompanied by an anthropomorphic monkey named Boots. Her journey in each episode has various obstacles which are overcome by solving a puzzle or game ("Dora the Explorer," 2013). Dora encourages her audience to participate both verbally and through physical movement, by asking the viewer to help her with a quest. Viewers learn about colors, numbers, shapes and more through helping Dora solve activities in an episode. This helps develop problem-solving skills, which was one of the main goals of the creators of the show ("Meet the creators," n.d., para. 1). Dora the Explorer also incorporates language learning by introducing Spanish vocabulary to its viewer.

RELATED RESEARCH

THEORETICAL FOUNDATIONS

TV viewing behavior

Research of children's behavior has provided an understanding of how they view television and the various processing models involved (Berger, Roloff & Ewoldsen, 2009; Bickham et al., 2001). Passive processing model refers to when the TV captures and controls the viewer's attention. Highly salient visual stimulus such as fast movement and sound that were thought to control the attention can in fact interfere with cognition and learning due to a sensory bombardment (Singer, 1980). This challenges the assumption that merely capturing the attention of the audience will facilitate better comprehension. The active model refers to when the child uses the medium deliberately to allocate their attention, working dynamically to comprehend the content of the television program. This is largely based on the program content, with children paying more attention to programs that are comprehendible yet not over-simplified (Bickham et al., 2001). The Dora second-screen application aims to bring users to actively engage with both the show and the accompanying activities.

TV facilitating learning

Television has been commonly criticized for its potential negative influence on the cognitive development and academic achievement of children (Zimmerman & Christakis, 2005; Singer, 1980), as well as contributing to the development of attention problems (Landhuis, Poulton, Welch & Hancox, 2007). However, research has demonstrated the positive impact of well-designed, educational television on preschool aged children (Rice, 1990; Schmidt & Anderson, 2007), especially for language development. Rice (1983) has documented a "link between the child as language learner and the child as television view". Simple dialogue, redundancy, visual salience, and repetition within TV dialogue can help teach new words to children, who have the ability to learn vocabulary incidentally (Rice, 1983). One of the purposes of the second-screen companion application for Dora the Explorer is to reinforce the language learning that is facilitated by the television.

Benefits of a Second-Screen

Educational applications on the mobile device have been shown to be effective. A study found that educational iPhone apps can boost 3-to-7-year-olds vocabularies by as much as 31% over the course of two weeks (Chiong & Shuler, 2010). Playing an interactive game can

have more benefit than watching a video of the same content. Lauricella, Pempek, Barr & Calvert (2010) discovered that children who played the interactive computer game and who observed the live demonstration, performed significantly better on the search task than children who observed the video. Based on these research studies, the Dora the Explorer second-screen app aims to combine the benefits of an educational television program and an interactive game.

CURRENT MARKET

Over the past few years, TV companion applications have become a popular tool used by shows and broadcasting networks to increase audience engagement. This is done by providing additional related content on a secondary electronic device, such as a tablet or mobile phone, to a TV audience. This development has been a response to studies showing that 87% of people are already using at least one second-screen device during TV watching (Graham, 2013). A majority of the second-screen applications on the market are aimed at an adult user base. Genres such as sports are utilizing the second-screen to provide statistics and player information of a game airing on television (NBA Digital, 2012). Apps for TV shows such as *Conan O'Brien*, allow the user to interact with friends and other fans, gain access to behind-the-scenes photos and trivia as well as watch video clips, interviews and web exclusives as shown in Figure 1 (Turner Broadcasting System, Inc., 2013).
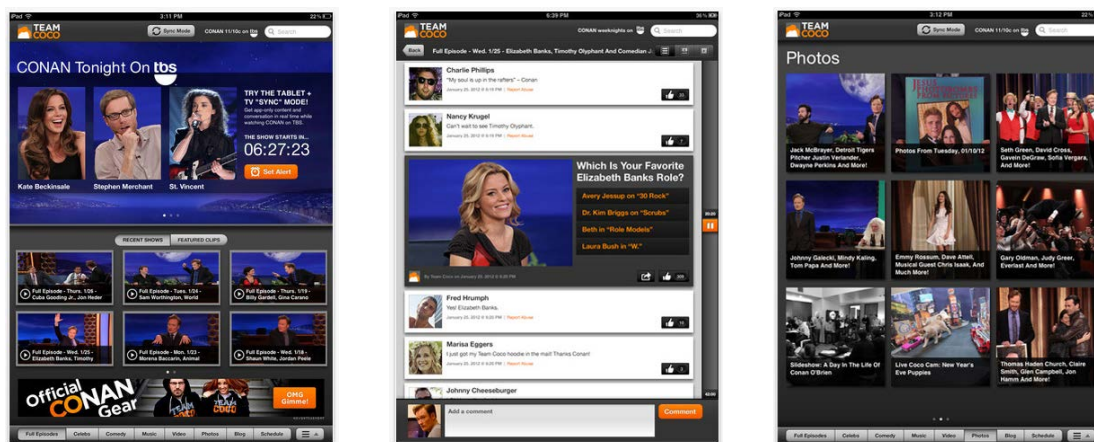

Figure 1 Conan O'Brien Companion Application

For children, there are only a small number of applications available in the market. The primary creator of second-screen apps for children is Disney, providing additional content via computer or iPad for select Disney films such as *Lion King*, *Bambi* and *Cinderella*. The *Disney Second Screen: The Lion King Edition* application provides storyboards, concept art, and games while the film is playing (see Figure 2) (Disney, 2011). The content which are contextual to the scene that is being shown on TV, does become a distraction to the viewing

experience, as the user is required to divert their attention from the TV to engage with the companion application. Also the games included in the Disney applications provide no educational benefits. The Dora the Explorer companion application differentiates itself from the current second-screen apps in the market, by providing an interaction model that minimizes distraction away from the narrative, as well as incorporating educational elements.

Figure 2 Disney Second Screen: Lion King

There are numerous iPad applications that provide educational benefits to children, with ten that are specifically related to Dora the Explorer. Some of these applications are a collection of learning activities, such as *Dora ABCs* (MTV Networks, 2013a) *Volume 1, 2, and 3*, where the child traces through letters of the alphabet to develop emerging literacy skills. Other Dora educational applications are in an interactive narrative format, such as *Dora's Enchanted Forest Adventures* (MTV Networks, 2013b). This format allows the child to tap through pages of a storybook consisting of static images with interactive elements (see Figure 3). Both these formats of the educational applications lack a video narrative that is provided in the TV episodes. Studies have shown the presence of a visual-superiority effect in children as they tend to "look but not listen" (Hayes & Birnbaum, 1980). The video narrative therefore is able to convey more information to the child, than the static images of the storybooks and activities.

Figure 3 Dora's Enchanted Forest Adventures

Educational applications are also developed in a game format which includes some cut-scenes from the TV episodes in between learning activities (MTV Networks, 2012). The differentiating factor of these games to the Dora the Explorer TV companion application is the length of video narrative that is viewed by the user. The cut-scenes only provide a fragment of the full length episode, which accompanies the companion app, therefore having less of an impact on the cognitive development of children (Linebarger & Piotrowski, 2009).

USER CHARACTERISTICS

The application is designed to be a second-screen companion to the children's TV program, Dora the Explorer. The target audience of this program was analyzed to determine the characteristics of the users of the application. Two types of viewing audiences were identified by conducting informal observation sessions: participatory viewers and passive viewers. The participatory viewer is vocally and sometimes physically responsive to the show and its activities. The passive viewer watches the show without responding to Dora's questions or joining in during the dances.

Table 1 Dora the Explorer Second-Screen Application User Characteristics

	Participatory	Passive
Age	4 to 5 years	5 to 6 years
Gender	Male and Female	Male and Female
Motivations	Seeks feedback on interactions with the TV Seeks to be entertained Wants to learn words	Wants an alternative method to verbal interaction with show Seeks to be entertained
Attitude	Verbally interacts with show Is enthusiastic about learning	May feel that responding to the TV show is redundant Shows some willingness to learn
Education	No school to Kindergarten	No school to Kindergarten

Other user characteristics also considered for the second-screen application are outlined in Table 2.

Table 2 Additional User Characteristics for Application

Visual Acuity	20/20 to 20/40 (Normal Vision to Mild Vision Loss)
Color Vision	Absent to Present
Audio Ability	0 dB to 180 dB
Working memory	0 to 2 +/- 2 chunks
Reading Ability	0 to 300 Lexile
Language abilities	English

The limited ability of young children to provide focused and sustained attention (Ruff & Lawson, 1990) was taken into consideration in the design of the application. The interaction model between the TV and the second-screen was designed to minimize the amount of dispersed attention between the two devices as much as possible. The limited working memory capacity of children was also factored into the design. Research has shown evidence of growth in working memory from childhood (Ottem, Lian & Karlsen, 2005), with the average adult memory capacity at 7 plus or minus 2 chunks of information (Miller, 1956). Therefore activities on the second-screen were designed to require a memory load that does not exceed 4 chunks of information.

While the target demographic of Dora the Explorer is 2 to 6 years of age, the target user of the application is limited to 4 to 6 year olds. This decision was taken based on the level of cognitive ability required to interpret the activities presented on the television, and on the ability to produce corresponding actions on a second-screen device, which may not be possessed by children aged 2 to 3 years. Also research has indicated that 5-year-olds benefit more in terms of language development while viewing television, than 3-year-olds (Rice & Woodsmall, 1988).

Dora the Explorer is currently broadcasted in 22 different languages (Havrilla, 2010). For the purpose of this prototype, the English version of the program will be used. Therefore, our user population is limited to those who understand English.

PERSONAS

Participatory Viewer

SOPHIE is 4 years old and lives with her mother and father in Atlanta Georgia. She is currently attending a local kindergarten 2 days a week, to help her socialize with other children and prepare her for attending preschool for the full week. During the days that Sophie stays home, she watches up to 5 hours of TV. This is done primarily alone, as her father, who works from home spends most of his time in the den, and her mother works as a full-time sales manager at a department store.

Some of the shows that Sophie enjoys watching are Sesame Street, Blue's Clues, Dora the Explorer and

Barney. While watching each of the TV shows, she is very engaged, responding both vocally and physically to any of the activities and questions that the characters in the shows present.

She is beginning to learn pre-reading skills such as recognizing the letters of the alphabet, the letter sounds, writing some of the letters and developing her vocabulary. She enjoys having story books read to her before bedtime. When she is not watching TV, Sophie likes to explore her backyard with the family dog, Oscar. She also likes to play games on her father's iPad such as Dora's Enchanted Forest Adventures.

Passive Viewer

BEN is 5 years old, who lives with his mother, father and 3 year old brother in San Diego, California. With both parents working full time, both Ben and his brother attend a local day-care center 5 days a week.

After returning from the day-care center, Ben and his brother are allowed a restricted amount of time in front of the television. Most of the shows they watch during this time are pre-recorded using DVR, as they are not home during the live airings. His parents are critical of the shows that he and his brother are exposed to, limiting their viewing choices to programs with educational elements.

Some of the shows Ben enjoys watching is Go Diego Go, Super Why, Discovery Kids and Dora the Explorer. Ben watches these shows in silence, ignoring any requests by the characters on the show to help or join in during activities.

At the kindergarten, he has begun to learn to read. He is able to match some spoken and written words, recognize some familiar words, as well as understand rhyming and play rhyming games. Ben's class also has begun to teach the different countries of the world, which has sparked his interest in languages other than English. Another activity that Ben enjoys is playing computer games on the family PC.

CRITICAL USE CASES

Active Engagement

One of the goals of the second screen application is to provide an interactive method of engaging with the show. This is facilitated by providing contextual activities on the second-screen that users can engage with the show. Based on their actions, users will be provided feedback on the second-screen, which is an improvement from the one-way interaction model that currently exists during TV viewing.

User's Purpose	System Responsibility
Watch episode on TV	Play episode video on TV
	Display default state on iPad
Observe engagement activity on iPad	Display contextual engagement activity on iPad
	Pause playback on TV
Interact with engagement activity on iPad	Provide audio and visual feedback on iPad
Continue watching episode on TV	Resume playback of episode on TV after successful completion of activity
	Return iPad to default state

Learning

The second-screen application is designed to support the learning elements of the show. This is done by contextually presenting both audio and visual elements on the second-screen to reinforce the vocabulary and Spanish language used in the show.

User's Purpose	System Responsibility
Watch episode on TV	Play episode video on TV
	Display default state on iPad
Observe vocabulary activity on iPad	Display contextual vocabulary flashcard on iPad
Interact with elements on the screen	Provide audio and visual feedback on iPad based on elements selected
Continue watching episode on TV	Return iPad to default state

The design of the second-screen application was an iterative process, beginning with initial analysis of the show to extract the key interaction points. These were captured in low-fidelity concept sketches and then further developed in more detailed digital mocks, before implementation into a fully functional prototype.

INITIAL STAGE

An episode of the Dora the Explorer was analyzed in detail for points of interaction that could be developed on the second screen. 19 possible points in time were selected from the episode, based on the learning content of the narrative and the type of engagement requested by the characters. Second-screen interaction activities for these points were then designed through paper-and-pencil sketches and storyboards. These visualized the screens and different stages of the iPad application (see Figure 4).
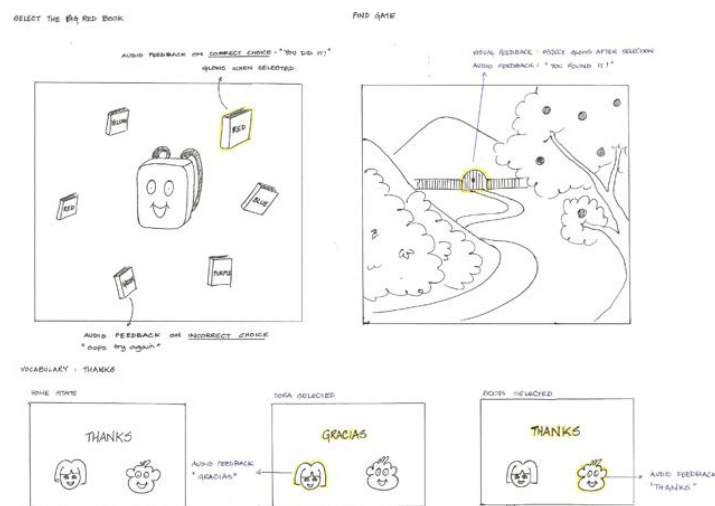

Figure 4 Pencil-and-paper initial sketches and storyboard

These initial sketches were discussed among HCI peers who provided heuristic evaluation. Improvements were made based on feedback. Subsequent iterations were created digitally using Adobe Photoshop and Illustrator to provide more detail. Some of the improvements based on the regular heuristic feedback are outlined in the sections below.

Inclusion of a default state

The application was initially designed to be used during specific activities throughout the show, and remain dormant when no interaction is required with the second-screen. This design model was altered based on feedback from HCI peers, to include a default state to be shown in between activities that require second screen interaction. The default state was designed to capture the progression of the episode over time. The visual representation used to show this information was of Dora traveling along a path, incrementally advancing with each second that passes on the show (see Figure 5).

Figure 5 Initial default state concept

Vocabulary Flashcards

One of the pedagogical elements included in Dora the Explorer is vocabulary learning. Second-screen content in the form of vocabulary flashcards were designed to reinforce the language learning promoted by the show. The original design of the vocabulary flashcard only showed the English words for the objects and characters of the show in context to when they appeared on the TV screen. This was designed to be traced along with one finger to also promote writing skills (see Figure 6). However this concept was discarded as the user would be distracted away from the TV episode for an extended period of time. Also input on the tablet device is provided using the finger, which requires different fine-motor skills and visual-spatial skills from writing on paper with a pen. This may cause some difficulty for the user.

Figure 6 Word Tracing Activity

A subsequent iteration of the flashcard was designed to facilitate learning of both English and Spanish vocabulary from hearing pronunciations of a word in both languages. Two characters of the show, Dora and Boots, displayed on the iPad screen, who when clicked provide auditory output of the word in Spanish and English respectively. The written English word would be visually displayed for the entire duration of the vocabulary flashback (see Figure 7). The feedback provided from peer evaluation, was the preference shown for the English version of the word from the vocabulary flashcard design, which could be perceived

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as bias towards a particular language. Therefore improvements were made to remove any bias in the following iteration, further discussed in the Final stage section.

Figure 7 Second Iteration of Vocabulary Flashcards

Activity Markers

A feature incorporated in the later stages of the design, was the ability to forward and rewind the TV episode to specific points in time. This is achieved through selecting activity markers from the default state. The initial concept designs had activity markers that would pop up above the path that Dora travels. This design was improved to provide a less cluttered interface, by placing the markers as dots on Dora's path in the default state (see Figure 8). The activity markers are color coded to identify the type of activity: blue represents the vocabulary flashcards, yellow represents the selection and finding activities. When two or more activities of the same type occur within one minute of each other, only one dot is placed on the path to represent the collection of activities.

Figure 8 Activity Markers

Feedback and Affordance

During the finding activities, if the user does not select the object within the first five seconds, a small amount of affordance is provided, as a hint. After the object is found and clicked by the user, audio and visual feedback is provided as positive reinforcement (see Figure 9).

Figure 9 Levels of Affordance in Finding Activities

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FINAL DESIGN

The final application design includes two categories of content: parallel and sequential. The parallel content is displayed on the second-screen while the TV continues playing. Sequential content is when the TV is paused, and the viewer needs to interact with the iPad to make the TV play again.
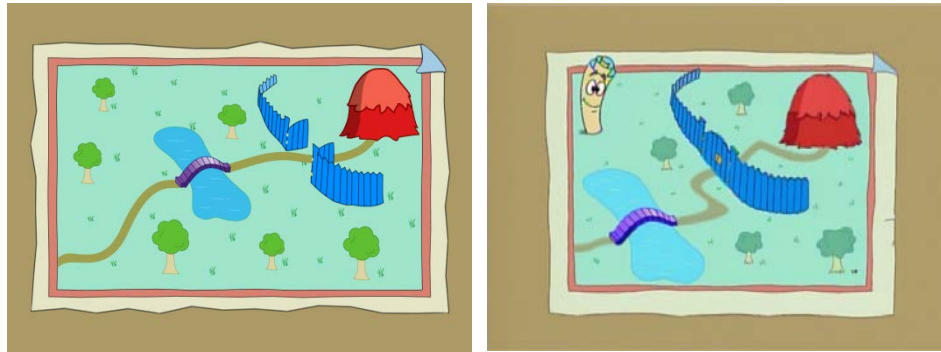
Parallel Content

Figure 10 Map used in the show (Left), Map used in the application (Right)

The default state of the iPad and the Vocabulary Flashcards can be classified as parallel content. The final design of the default was improved from the previous iteration, by having the path resemble the map that is used in the show (see Figure 10). This was done to increase immersion into the world of Dora, as well as to reinforce the map reading skills that are promoted from the program. The map path was slightly altered to enable Dora to travel at a constant rate for the duration of the episode.

The final design of the Vocabulary Flashcards showed both Spanish word and English word (see Figure 11) simultaneously on the screen, as well as the two characters each speaking the words in a specific language. All elements in the screen provide visual feedback when clicked, and audio output of the pronunciation of the word.

Figure 11 Final vocabulary flashcard design

Sequential Content

The finding and multiple choice activities can be classified as sequential content. The finding activity occurs when Dora asks the audience to locate an object within the scene. The TV is paused, and the iPad displays the same scene, with the object as an interactive element. The TV is set to play again, after the object has been located and clicked (see Figure 12).

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Figure 12 Sequential Activities: Finding Activity (Left), Multiple Choice Activity (Right)

The multiple choice selection activity is presented when the audience is asked to help Dora by finding the right object from a collection. Similar to the finding activity, the TV is paused and the iPad changes from the default state to show the multiple choices. If an incorrect choice is selected, audio feedback is provided to the user. The TV is set to play again, once the correct choice is made on the iPad.

The application is intended to fulfill several of the usability and user experience goals, as defined by Sharp, Roger and Preece (2011). The primary goal is the effectiveness of the application in encouraging users to actively participate and learn while watching TV. As the system is targeted at children, interaction and execution of actions within the application have been designed to be simple, drawing on familiar concepts so there is a very little learning curve. The simplicity of interacting with the game would also foster memorability in how to use the system, which is important in providing an enjoyable overall user experience. Other User experience goals include making the application engaging for children, as well as providing a level of cognitive stimulation.

IMPLEMENTATION

The system includes three components: the database, TV and iPad (see Figure 13). The database is hosted on a web server, and stores three values: the time-point of the video, the activity state as a binary value and the activity type. It is in constant communication with the TV and iPad to ensure the content on both devices are in sync.

Current Episode Time

Play / Pause
Forward / Rewind

TV

Current Episode Time

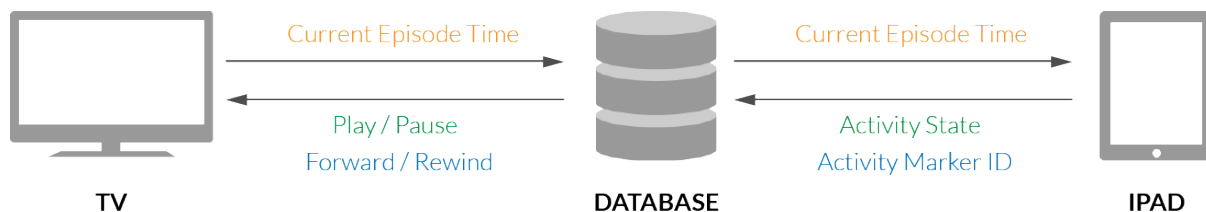Activity State
Activity Marker ID

DATABASE

IPAD

Figure 13 System Diagram

The video of the episode is streamed on a web-browser enabled TV, and displayed on a HTML5 page with an embedded flash player. The styling of the page is defined using CSS3. JavaScript is used to periodically check the current time-point of the video and to send a PHP request to update the time value stored on database. The HTML5 page also polls for instructions from the server, specifically the activity state which translates to the video being played or paused, and the activity marker which forwards or rewinds the video (Murray et al., 2012).

The second-screen application is run on a browser of the iPad as a web application. The database is periodically polled by the iPad app using PHP and MySQL, to determine the activity that needs to be presented. A HTML5 page linked to a CSS3 style-sheet, displays an activity by pulling the appropriate images and audio from the web server. JavaScript is then used to build certain interactions within the activity. When a sequential activity is displayed, the activity state is periodically updated to the database in accordance with whether the user has been able to successfully complete the task. The Activity ID is updated when an activity marker is chosen from the default state, to affect the time position of the video playing on the TV.

The visual images used for the different states of the iPad application were built using Adobe Photoshop and Illustrator. The audio files used for system feedback and language learning were sourced from online catalogs and the original show video respectively, and edited using open-source software. A more detailed system diagram is provided in Appendix A.

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METHOD

The main objective of conducting evaluation was to gauge the usability and initial user experience of the application, based on the goals defined during design. Individual sessions were conducted, consisting of a direct observation segment followed by a brief semi-structured interview. Assent from the participant was sought verbally, at the beginning of the session (see Appendix C). During the direct observation segment, participants were asked to watch Episode 1, Season 1 of Dora the Explorer on TV, and concurrently use the companion application on the iPad. The participant was then given instructions regarding when and how to use the iPad application. Instructions were provided to the young participants using simple language for easier understanding. The behavior and performance of each activity was noted, as well as any remarks made while using the application. The duration of the observation session was approximately 25 to 30 minutes.

The semi-structured interview that followed the observation session was to gauge the participants' thoughts on the experience and opinions of the application and its features. In preparation for the interview, research was conducted on protocols and guidelines for conducting a successful interview session with children (Kyronlampi-Kylmanen & Maatta, 2011). The duration of the interview was for about 5 - 10 minutes, to ensure the young participant did not feel overwhelmed.

The entire session was video and audio recorded for note-taking purposes. The sessions were conducted in a quiet, private room within the participants' school (see Figure 14). This environment was chosen to allow participants to complete the session without external interruptions, yet be constantly observable from outside, to ensure the safety of the participant and the interviewer (Gill, Stewart, Treasure & Chadwick, 2008). The details of the evaluation session protocols are provided

Figure 14 Evaluation Setting

in Appendix D.

PARTICIPANTS

After receiving approval from the Institutional Review Board at the Georgia Institute of Technology, a preschool class in metro Atlanta was contacted to recruit participants. With the help of the school faculty, permission documents were sent to the parents of all 16 students in the class (see Appendix B), of which nine were granted. These nine students were recruited for user evaluation of the application, ranging from five to seven years of age. Four female and five male participants were recruited from the kindergarten and pre-school class of a school in metro Atlanta. The participants were of English-speaking background, and varying ethnicities. Only one participant was aged seven, which does fall outside the target demographic of Dora the Explorer. However, as the participant had turned 7 a week prior to the study, their involvement and feedback was still considered useful to the study. Attempts were made to include four-year-old children into the evaluation study, as they would also fit the target demographic of the show, as well as the user characteristics defined for the application. However due to lack of consent received from parents, this was not achievable. All but one participant had watched Dora the Explorer in the past, or was currently watching the show regularly.

OBSERVATION RESULTS

During the observation session, all the participants kept their attention on the television for a majority of the time, looking down intermittently at the iPad while it was in default state. They would, however, provide focused attention to the second-screen when the TV was paused. Three of the participants responded verbally to Dora's questions throughout the show alongside using the iPad app. The remaining users watched the show passively in between interactions with the application. The activity performance of each child is visualized in Figure 15. The results are categorized into sequential and parallel activities.

Figure 15 Performance of activities from iPad application

Sequential Activities

The first selection activity caused issues for most of the participants. Only three of the participants were able to successfully complete the task without any assistance, while the remaining either needed some assistance to complete the task or did not make any attempts to interact with the elements after looking at the tablet device. Some stated that they did not know what had happened or what they were required to do when the TV initially paused and

the iPad changed from the default state to the first activity. *"Why did this turn into that? I can't un-pause it"* – P1 in reference to the screen change of the iPad and the TV respectively. Some participant assumed that clicking anywhere on the iPad screen would resume the playback on the TV. The sequential activities that followed had a higher success rate. Some participants would be poised, ready to make a selection on the iPad, in anticipation of an impending TV pause and state change on the second-screen. All participants used the clicking interaction style to select an object on the screen of the iPad. Only one participant used a dragging motion for the *Find Pieces* activity rather than clicking on the item, therefore needing some assistance to complete the task.

Parallel Activities

The participants did not interact with any of the parallel activities during the observation session. When the vocabulary screens were shown on the iPad, all participants looked down momentarily before diverting their attention back to the television. Two participants did not notice the last vocab activity screen at all, with their attention being focused on the TV for the entire duration that the iPad displayed the activity. Also no activities were selected using the activity markers on the default state of the application, to move the TV show back or forward in time.

Upon follow-up in the interview, it was also revealed that some of the participants did not realize that the elements were clickable, which could attribute to the lack of interaction. Also participants stated that such a screen could be used to facilitate learning of Spanish and English words.

INTERVIEW RESULTS

All participants had a positive impression of the application after use. Some of the descriptions used were "interesting" "good" and "fun". The difficulty level of the application was described as easy to moderate. When given the choice of interacting with the TV show through the second-screen application, or responding verbally to Dora, all the children preferred to use the application. The second-screen was described as being a more fun method, and participants felt they would use such an application regularly if it were available.

However, pausing of the TV for some of the activities received a mixed response. Some of the participants preferred the feature as it meant they would not be missing out on the show. *"I like the pausing because when you're doing things, you don't have to catch up"* – P5. Two participants described the TV being paused was confusing, and would prefer the TV continue playing during all activities. One of the participants considered this as confusing, but also felt

the speed of interaction with a parallel model would be unmanageable. *"If the TV didn't pause, it would be less confusing. If it is playing at the same time though, it would be going too fast"* – P4.

During the interview, the children were asked about the activity markers or map dots as they were described during the interview. None of the participants had interacted with these dots during the observation session to move the episode on the TV forward or backward. Three of the participants had some sort of idea of what these dots represented. *"You press the dot, you'll go back to where [the TV show] was"* – P1, *"The dots are where all the stops were"* – P3. The others either did not know why they appeared or thought they were something unrelated to skipping through the episode. After explaining the purpose of the dots, four of the participants continued using the application only by pressing them as a way navigating to the most interactive points of the TV show. The blue dots were not differentiated from the yellow dots, with one participant perceiving a blue dot as the *"most exciting"* activity, but not recognizing as representing vocabulary flashcards.

Informal feedback was also provided by several parents of young children (during the demonstrations held on GVU open day). The application was perceived favorably as they felt the activities promoted active participation rather than passive consumption of TV. The passive nature of TV viewing was voiced as a primary concern of parents, who try to limit the amount of TV their children watch for this reason. *"We don't let our kid watch too much TV because it's so passive, but this would be a great alternative"*. Parents also found the activity markers to be a compelling feature, to enable children to navigate to different points in the show on their own.

From the evaluation, the usability of the application did meet the goals set during design. Users were able to learn and remember how to interact with the application to complete the tasks, including those who had some confusion at the beginning. From verbal feedback, the application was considered engaging and enjoyable, however this need to be corroborated with further observational testing due to possible confounding factors discussed in limitations. The application was also effective in inducing active participation by children while watching TV, however not all activity types had the same level of interaction. Sequential activities elicited more interaction from the user than parallel activities, however there may have been other factors that contributed to this behavior result, such as familiarity and lack of affordance, further discussed in next steps.

The effectiveness of the TV pause and play model was also inconclusive from this evaluation study and would require further testing. While some of the participants describe the TV pausing as confusing during the interview, the observation results showed confusion was experienced only during the initial activity. The sequential activities that followed were completed successfully by all participants without any hesitation. Also anticipating the TV to pause and iPad to change states also indicates signs of learnt behavior, which would suggest that the participant was experiencing very little confusion.

Unexpected behavior that surfaced from the sessions, was the continuous use of the activity markers as a method of navigating to interactive portions of the show. Informal feedback gathered from parents revealed that when children were given a limited time to watch TV, they often requested for a show to be forwarded or rewound to specific points. The activity markers of the application allow the child to be in control of seeking out a particular point in the show, without the help of the parent.

LIMITATIONS

Extra caution needs to be taken when interviewing children, to ensure unintentional interviewer bias is minimized as much as possible. From juxtaposing the observational results to the interview responses, some children who had experienced difficulty and frustration during the use of the application stated a positive impression of the application. This may have been due to a desire to please the researcher which needs to be taken into consideration when analyzing the feedback.

During the evaluation sessions, the components of the system utilized the internet connection of the testing location in order to operate. However, the slow connection speed

and strength caused some performance issues for the application. Some of the feedback that was designed to be instantaneous experienced some delay, which took away from the seamless syncing of the different components during some of the sessions. This may have had a negative effect on the behavior of the user and the overall impression of the application.

A restriction of iOS devices is that all audio used within an application needs to be triggered by the user, and does not play automatically. This limitation prevented including audio as a form of indicator when the iPad changed states from the default to an activity. This feature would especially be useful during the parallel activities for which the TV continues play, causing some of the users to not realize the state change on the second screen.

The 5-year-old participants showed more enthusiasm and engagement with the second-screen application than the 6 and 7-year-olds. This suggests that the application may be more suitable to a younger demographic. Being able to test the application on 4-year-olds would have provided more data to support this hypothesis. However, as mentioned earlier, due to lack on consent provided by parents of the 4-year-old students asked to participate, this was not possible.

NEXT STEPS

Based on the findings from the evaluation sessions, the next steps in terms of design would be to incorporate a tutorial during the initial activity on the second screen. This tutorial would be designed to teach the user the basic interactions and expectations of the app, which would address the difficulty experienced during the first activity in the user tests. Another approach could be to include a "helper" to act as a guide while the user watches a sample activity.

In the current design, the TV remains paused until the sequential activity is completed correctly. Providing a timed continuation feature for the sequential activities would allow any user who is unable to complete a task, to still be able to continue through the episode on the TV.

The elements of the vocabulary activities require increased affordance that highlights its interactive capabilities. This can be done through styling the elements to glow or blink. However, further testing will need to be conducted to determine whether the change is effective. If interaction with activity is still lacking, other factors may need to be explored, such as changing the activity from parallel to sequential. Another factor that needs to be considered is participant's familiarity to the vocabulary words, which may reduce the curiosity to explore. From the interviews, it was revealed that all the participants knew the English and Spanish words that were shown in all of the Vocabulary flashcards. The

interactions with the flashcards could also be elaborated if it became a sequential activity, as the child would have more time and focused attention. Individual letters could be moved around the screen by the child to spell out the word displayed, rather than tracing the word as proposed in the initial design. By including animation when the letters are moved, such as the o's being able to roll, it would reinforce their physical characteristics of the letters as done in the Montessori Method (Montessori, 1912).

The color of the activity markers were not discernible as representative of a type of activity, therefore need to be redesigned. Icons that symbolize vocabulary activities and find/select activities can be placed on the path. To build connection and memorability of the icons, they would be also displayed on the activity screen.

The prototype can be used as a framework to develop second-screen content for all episodes in a season of Dora the Explorer. This would enable longitudinal testing to be conducted to determine the effectiveness of the engagement and learning elements of the app. The longitudinal study would be designed as a between-participant quasi-experiment, where one group of participants will be given the second-screen application to use while watching a season of Dora the Explorer, and compared against a control group who also watches the same season of the show, but without any companion application. Learning would be measured through conducting pre and post-tests on both of the groups. Engagement would be measured through analysis of behavior from direct observation as well as video diaries that parents will be asked to keep. The study would be done in a home setting, where behavior is more likely to be natural. A younger age group would be recruited for the next round of studies, as many of the current participants were watching Dora the Explorer one or two years prior, and were currently not regular viewers. This would suggest that this show has more appeal to ages 3-5.

Gamification techniques can also be included to provide an incentive to keep using the application (Chiong & Shuler, 2010). Scores can be provided for each activity based on time taken and action counts. This would introduce a sense of challenge and motivation to improve. Based on informal feedback from parents, it was found that children watch episodes more than once. Therefore, children could replay the same activities when repeating an episode, with different outcomes. Hidden levels could also be revealed at the completion of all activities, to encourage use of the application for the entire duration of the show.

We can also apply the design to another children's show with differing levels of pre-existing interaction and engagement. This will determine the extensibility of the second screen application to beyond the program style of Dora the Explorer, where less active participation is already encouraged.

CONCLUSION

Based on the current trends, TV viewing will continue to be a significant activity in children's lives. The need to ensure this time is productive to the development of young children will become increasingly important. This project has demonstrated a design concept to encourage active participation and learning during TV viewing. The Dora the Explorer second-screen application provides a feasible solution as TV companion application that is designed for children. An interaction model between the TV and second-screen has been developed, that is distinct from current market applications, to better cater for a younger demographic.

Second screen applications have seen a huge growth in the market, as TV content providers have begun to realize its potential to attract and retain viewers. While children's television programs have largely been silent in this new frontier, children can also benefit from the second screen. Children are growing up in a digital age, with increasing exposure to mobile devices and technology from a young age. TV programs should harness the familiarity that children have with such devices to create meaningful interactions and information for young viewers on a second screen, and in turn create a positive impact on a TV centric young generation.
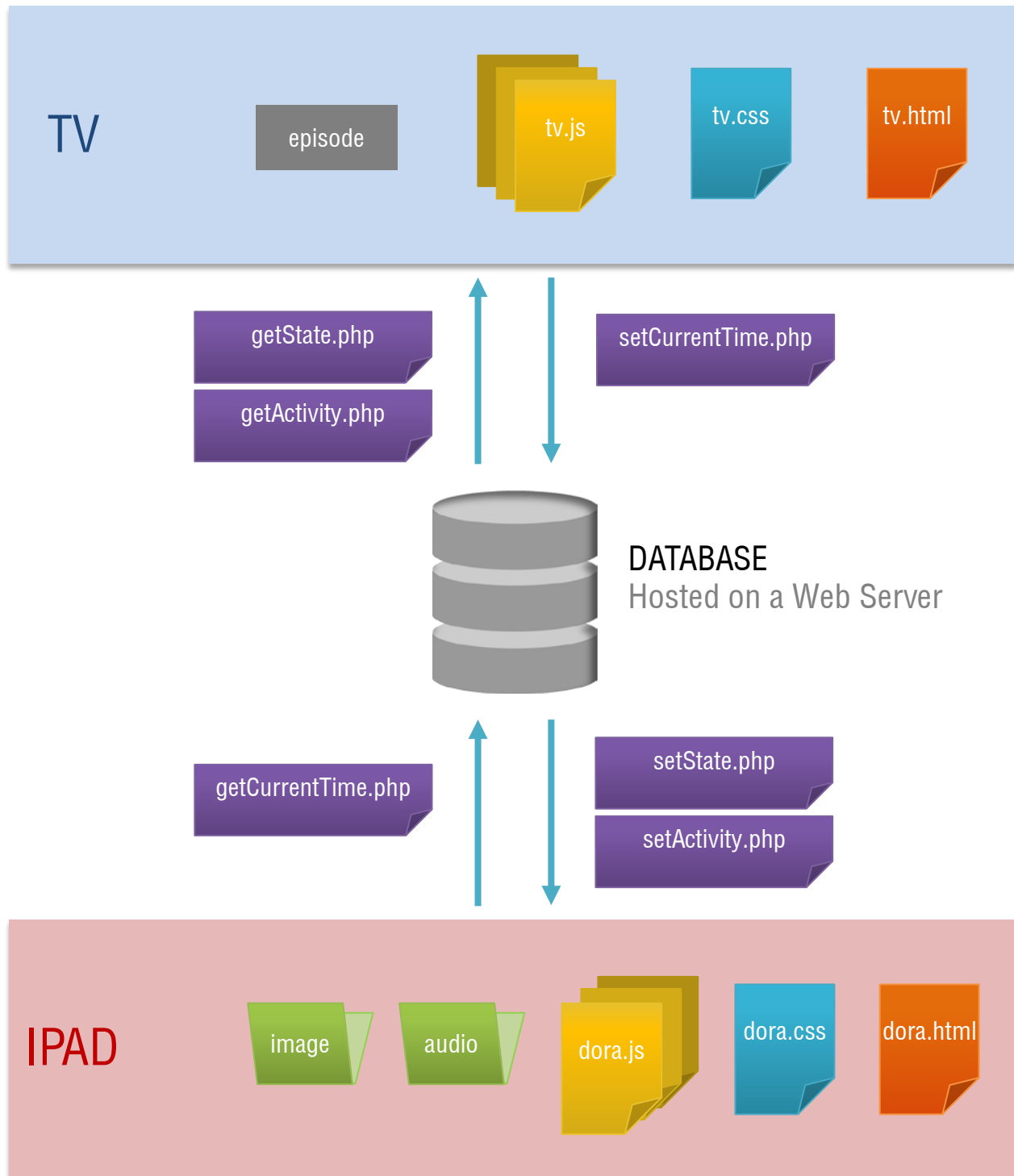
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APPENDIX A   DETAILED SYSTEM DIAGRAM

PARENTAL PERMISSION DOCUMENT FOR ENROLLING MINORS IN A RESEARCH STUDY

Georgia Institute of Technology
Project Title: *Evaluating the use of an Educational TV Companion Application for Children*
Investigators: *Janet Murray and Zuiena Kabir*

You are being asked to allow your child to be in a research study.

Purpose:
The purpose of this study is to evaluate whether our tablet application for *Dora the Explorer* can help children engage with activities throughout the show and learn early childhood literacy and numeracy skills. We expect to enroll 8 children in this study.

Exclusion/Inclusion Criteria:
Children in this study must be aged between 4 and 6 in order to fit the target audience for the children's show, *Dora the Explorer*.

Procedures:
If you decide to allow your child to be in this study, his/her part will involve participating in a single session taking place at school. We will ask your child to watch an episode of Dora the Explorer on TV (25 minutes in length), and provide them an iPad with a Dora the Explorer TV companion application installed. We will then observe the child's use of the application while watching the show. At the completion of the episode, we will then ask your child a few questions about the experience. The interview will be approximately 10 minutes. The total duration of the session will be 35 minutes and will be conducted individually with each child. You or your child can choose to stop the study at any time. Some important points to consider before deciding whether you want to allow your child to participate:

- We will keep all data collected from this study as confidential as allowable by law.
- With your permission and that of your child, we will video record the session. Your child's face will not be captured in the recordings, and his identity will not be revealed to anyone who sees the video. These recordings will be erased once the files are transcribed.

Risks or Discomforts:
The overall risk level of participation in this study is minimal. The risks involved are no greater than those involved in daily activities such as reading a book, or playing a game on tablet device.

Benefits:
Your child is not likely to benefit in any way from joining this study. We hope that what we learn will help us improve our application to better teach and allow children to interact with TV shows.

Compensation to You:
Your child will not be compensated for his participation in this study.

Confidentiality:
The following procedures will be followed to keep your child's personal information confidential in this study:

- The data collected about him will be kept private to the extent allowed by law. To protect his privacy, your child's records will be kept under a code number rather than by name. Your child's records will be kept in locked files and only study staff will be allowed to look at them. Your child's name and any other fact that might point to him will not appear when results of this study are presented or published. Your child's privacy will be protected to the extent allowed by law. To make sure that this research is being carried out in the proper way, the Georgia Institute of Technology IRB may review study records. The Office of Human Research Protections may also look over study records during required reviews.
- All video recordings of the sessions will only be viewed by the investigators for note taking purposes. The video tapes will be kept secure in a locked office, with only access to study staff. Once the study ends, the video tapes will be erased.

Costs to You or Your Child:
There are no costs to you or your child, other than your time, for being in this study.

In Case of Injury/Harm:
If your child is injured as a result of being in this study, please contact Janet Murray at telephone (404) 894-6202. Neither the Principal Investigator nor Georgia Institute of Technology has made provision for payment of costs associated with any injury resulting from participation in this study.

Participant Rights:
- Your child's participation in this study is voluntary. He does not have to be in this study if he doesn't want to be, *even if you give your permission.* Your child will be asked separately if he wants to be in the study. If he decides not to participate, he will not be enrolled even if you have agreed that he may.
- You have the right to change your mind and remove your child from the study at any time without giving any reason and without penalty.
- Any new information that may make you change your mind about allowing your child to be in this study will be given to you.
- You will be given a copy of this Parental Permission form to keep.
- You do not waive any of your legal rights or those of your child by signing this Parental Permission form.

Questions about the Study:

If you have any questions about the study, you may contact Dr. Janet Murray at telephone (404) 894-6202 or janet.murray@lcc.gatech.edu.

Questions about Your Child's Rights as a Research Participant:

If you have any questions about your child's rights as a research participant, you may contact:

> Ms. Melanie Clark,
> Georgia Institute of Technology
> Office of Research *Integrity Assurance*
> (404) 894-6942

If you sign below, it means that you have read (or have had read to you) the information given in this Parental Permission form, and you would like for your child to be in this study.

_____

Child's Name (printed)

_____

Parent's Name, Printed

_____   _____

Parent's Signature   Date

_____   _____

Signature of Person Obtaining Consent   Date

VERBAL ASSENT SCRIPT FOR CHILDREN AGED 4-6

Project Title: *Evaluating the use of an Educational TV Companion Application for Children*
Investigators: *Janet Murray and Zuiena Kabir*

Hi. My name is Zuiena Kabir. I'm a student at a college. Right now, I'm trying to learn about how to make watching TV more interesting and educational. I would like to ask you to help me by being in a study, but before I do, I want to explain what will happen if you decide to help me.

I will ask you to:
- Watch an episode of Dora the Explorer on TV
- Play the iPad game while Dora the Explorer is playing on TV
- Answer some questions about the game and how you feel about it. There are no right or wrong answers.
- Let us audio or video record you playing the game and answering questions

By being in the study, you will help me understand using the iPad while watching TV is a good thing. Your parents and teacher will not know what you have said. When I tell other people about my study, I will not use your name, and no one will be able to tell who I'm talking about.

Your parents say it's okay for you to be in my study. But if you don't want to be in the study, you don't have to be. I won't be upset, and no one else will be upset, if you don't want to be in the study. If you want to be in the study now but change your mind later, that's okay. You can stop at any time you want. If there is anything you don't understand you should tell me so I can explain it to you.

You can ask me questions about the study. If you have a question later that you don't think of now, you can call me or ask your parents to call me or send me an email.

Do you have any questions for me now? Would you like to be in my study and begin using the iPad game while watching Dora the Explorer and answers some questions?

Name of Child   _____
Child's Voluntary Response to Participation   ☐ Yes   ☐ No
Parental Permission on File   ☐ Yes   ☐ No
Signature of Researcher   _____
Date   _____

EVALUATION SESSION PROTOCOL

Project Title: *Evaluating the use of an Educational TV Companion Application for Children*
Investigators: *Janet Murray and Zuiena Kabir*

OPENING COMMENTS & INTRODUCTION (5 mins)

- Introduce myself, explain the purpose of the interview, and describe the session.
- Read and explain the assent form.
- Note the response for participation request on the assent form.
- Answer any questions about the study.

EPISODE VIEWING & APPLICATION USE (25 mins)

- Hand the child an iPad with the *Dora the Explorer* application installed.
- *"I want you to press the Dora the Explorer app on the iPad. When you are watching Dora on TV, use the iPad when you see something on the iPad screen."*
- Turn on a Dora the Explorer episode on TV.

DISCUSSION ABOUT THE APPLICATION (5 mins)

1. What did you think of the game?
2. What did you like? What did you not like?
3. Would you play this game while watching Dora?
4. What other shows would you want a game like this for?
5. Was there anything that was hard to do in the game?

"Thanks for your help!"