PART A: GENERAL

Question 1: Goals and Users

Application Goal
The goal of this application is to teach fundamental behaviors that revolve around the importance of cleaning tools, techniques and physical safety in what is normally one of the most dangerous areas of the home — the kitchen. Three learning components exist within the application and allow a user to focus on 1) physical safety, 2) cleaning tools and techniques for things you can't see (like bacteria) and 3) cleaning tools and techniques for things you can see (like pests). The focus of this project was to take component 3 and attempt to teach users about the consequences of ignoring unsanitary conditions with respect to pest infestation. Interactive methods allow the user to control the conditions and watch the progression of results over a period of time. The main, interactive characters in this segment of the program section are colonies of ants. The project is developed as a stand-alone tool that could be used to reinforce the learning objectives within a curriculum or learning plan about cooking, household safety, or family chores.

Intended Users
The program could be used within a classroom or as an external resource for children in scouting programs who can earn badges for demonstrating learning in these areas. The age range targets 1st through 3rd graders, corresponding to the early years (such as Brownies and Cub Scouts) in extra-curricular programs. This group of users is ripe for understanding the functionality of the kitchen within a home and is also mature enough to begin understanding the consequences of their actions, whether it is leaving a dirty dish on the table or an overflowing garbage can under the sink.

Intended Achievements
The program is intended to familiarize children with kitchen scenarios and how to avoid hazardous or unsanitary conditions. Not only does it allow them to understand the progression of situations, but allows them to control a cure for the issue at hand. While the specific lesson described here is not expected to entertain children for more than 10-15 minutes, the users should be able to transfer this important information directly to their own household even in that short span of time.
Once the child has finished exploring and playing with the application, we expect they will recognize the importance of promptly cleaning up kitchen messes. User testing confirmed that the identification of the importance of cleaning and the positive and negative consequences of such actions was relevant and valid.

**Question 2: Inspirations**

**Inspirations**

Key inspirations came directly from other websites available on the World Wide Web. There were no retail applications available in computer or toy stores. On the contrary, comparative inspirations were free web-based programs accessible directly through an Internet connection. The subsequent sites listed below provided stimulation and insight in the following ways:

http://www.fsai.ie/kids/clean_home.htm: The important contributions from this site came in understanding that there is a market for children in primary schools to be educated about the risks of food poisoning and food safety. A major effort in learning about this comes through the instruction about cleaning and contamination. And since all of these components are part of the kitchen environment, it’s important to place the child in that realistic scenario. From here we borrowed the target market and decided to aim our program at a viable group of users — primary school children, ages 6-10.

http://www.welltown.gov.uk/home/kitchen.htm: Welltown is also an important indicator of the need to teach young children about health and hazards around the home. The kitchen activity provided a good foundation for the level of interactivity that children might want to see in a computer-based program. We shared key design ideas about the need for feedback as we recognized the program’s capability to show children the results of their actions.

http://www.foodlink.org.uk/kitchen_test.htm: Foodlink provided helpful insight into how children might prefer to interact with menus and toolbars — we looked at the graphical organization and considered how best to lay out the tools and options that would be used in our application. We also considered how much flexibility we’d give the users during the exercise. Furthermore, we also took into consideration some helpful negatives, including the overpowering color combinations that might be more of a distraction, thus hindering the learning process.

**Question 3: Design Priorities**

**Most Important Design Priorities**
Learnability is one of the most important design components considered during our design process. The system must be adaptable to young children who, as shall be mentioned in the design principles section, must be able to learn with potentially little or no background knowledge about how an unsanitary environment may attract the pests that are present in the system. The children must be able to successfully engage in a system that is easy to learn and that which can be quickly adapted to in order to learn how to execute tasks without prior knowledge.

Secondly, satisfaction is a major design priority that is especially important when dealing with young children. If a child does not successfully engage in a learning program because of dissatisfaction with the interface, the ease of use or general entertainment value, the tool has immediately failed from the outset and has little chance of gaining acceptance by the young user.

How Design Priorities Were Motivated by Intended Audience

These two priorities are clearly recognized as critical considerations when we take into account our young users. For successful engagement by our defined audience, there must be an element of satisfaction because this immature group does not otherwise understand the motivation for learning these concepts. From an educator’s point of view, once the program engages the user, it is critical to make sure that there are adequate and well-defined methods for learning. The only way to extract knowledge then, is to make sure that the topic is learnable.

The intended audience has a limited attention span, and we wanted to ensure that the program offers a healthy dose of interactive possibilities with which to maintain engagement. Cognitive and physical limitations of children this age led us to incorporate a large font size, audio-based narration to complement the instruction screen, and the use of a wide range of other interactive sounds.

Question 4: Features

Most Interesting Feature

We chose to profile two interesting features from our application. The first intriguing component is the ability to win stars by executing the appropriate task to rid the ants from the kitchen. Conversely, we implemented negative response — the attracting of ants when the correct task is not implemented. These are visual and measurable methods for positive and negative feedback and prove to be valuable motivators in our user studies.

The second interesting feature is the implementation of an introduction screen that clearly describes pictures and provides comments in order to help children, before they enter the game, familiarize themselves with the current problems and the tools used to combat the problems. This reduces a fundamental barrier to frustration that might otherwise ensue if the young child is forced to utilize his or her own basis of knowledge — a knowledge level that may not otherwise be extensive enough to elicit successful outcomes.
Question 5: User Testing

While we originally targeted our application towards a perceived, educational need for college-age students, our first user test warned us that the intended audience was not interested in any sort of resource in this context. Using that feedback to our advantage, we refocused our design and made adjustments to target a younger age group that could benefit from this educational application.

User Testing Scenario

We went through a number of rounds of user testing and broke it down into two formats as described below.

<table>
<thead>
<tr>
<th>Testing Type</th>
<th>Audience</th>
<th>Timeframe</th>
<th>Context</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concept Testing</td>
<td>Adults: 7</td>
<td>2 weeks</td>
<td>Verbal, paper-based,</td>
</tr>
<tr>
<td></td>
<td>Children: 2</td>
<td></td>
<td>storyboard mockups</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>and online</td>
</tr>
<tr>
<td>User Testing</td>
<td>Paper: 5</td>
<td>2 weeks</td>
<td>Paper-based, online,</td>
</tr>
<tr>
<td></td>
<td>Online: 2</td>
<td></td>
<td>and interactive</td>
</tr>
<tr>
<td></td>
<td>Total: 16</td>
<td>4 weeks</td>
<td></td>
</tr>
</tbody>
</table>

Concept testing began with basic sketches and storyboards presented to the first round of testers in order to gauge interest and difficulty level. In the second level of user testing we tested our interactive paper prototype while continuing to flush out the online prototype. At the same time, we referred back to the paper prototype to get additional feedback where possible.

User Testing Results

Most importantly, the first round of user testing redirected the selection of our target audience. A fourteen-year old subject thought the whole thing was dumb. Teenagers and college-aged students are generally more suspect of efforts to help them with neatness and cleanliness and, as we discovered, are not particularly engaged with or interested in this type of activity. A comment from a twelve-year old was noteworthy. So ants like all foods. What's the point? It became clear that younger children are more open and willing to explore the program to try and understand the game itself.

Once the target audience of younger children was clearly defined, we were able to redirect our process and focus on more elementary skills. Further feedback then became appropriately pointed at the application and its functionality. Studies with the next group of users from the target audience provided specific reaction to the messages under the hints button. They felt that these hints were too specific and directed. For example, The peanut butter jar is attracting lots of ants would be preferred to Put the lid on the peanut butter jar.
Kids clearly expressed that they liked the avatar — the ant guide personality. There were vocal differences about which gender and what its name should be. A gender-neutral guide was determined to be less inflammatory and distracting while maintaining an engaging relationship with the user.

User testing further uncovered children at the younger end of our target age range do not necessarily have the fine motor control necessary to target some of our smaller icons, and we would need to adjust the size of these controls.

The explorable screen in the beginning of the application proved, through user testing, not only a valuable tool to introduce users to the intellectual learning (what items attract ants, and why), but also a familiarizing agent for foods and items in the kitchen.

**Conclusive Feedback**

We were pleased to discover that children in our resulting target age range enjoyed using the program, and voluntarily spent time exploring even the simplified and limited prototype. Criticisms from adults rendered some concern that the program might be too simple, but one 7-year old user said, It's a good program because it's hard. The children viewed the game portion as a puzzle, where they had to figure out what was wrong and how to fix it.

We did discover some discrepancies between the adult audience and the children during the user tests. It was clear that the mop and broom tools were easy for the kids to manipulate but confusing for the adult user group. On the contrary, functionality like the positive reinforcement gained by winning stars was appealing to both audiences. And similarly, the interactive sounds that provided additional feedback were well received in both user groups.

**Changes as a Result of Testing**

Clearly, our initial user feedback meant that we had to refine our product to accommodate our new group of users. We had to look at new motivations and design principles that repositioned the same learning problem so that it appropriately addressed the new audience. This required us to adjust the skill level and the context of our original application. We not only carefully refined the scenarios that the application presented but we also deliberately refined the kinds of choices offered. For example, we knew that a six-year old child would not or should not have access to poisonous sprays (a solution tool in the application originally intended for college-age students) and thus, we had to change the components in our tools menu.

We also investigated and incorporated new principles — like working at it from a more behaviorist perspective (for children) rather than a cognitive perspective (for adults who have previous knowledge) and made our program work for them. This was directly applied in the introductory, explorable screen, providing children some background knowledge that they might not have and might need in order to progress confidently through the game.
Future Changes and Next Generation Enhancements

Features: SCREEN 1

**Continue arrow:** The Continue arrow is not clearly designated as a clickable item. For a future iteration, the icon should be outlined or highlighted. Putting the word continue within the arrow itself would combine the graphic and text and probably be the best integration of information.

**Help button:** The Help button should be changed to the title instructions since children expected help when they clicked on the icon and it just took them back to the instruction screen. Further, more differentiation of Hint and Help is indicated. We would rewrite the Help and Hint screens to provide more explicit directions (in Help) and less-directive hints.

**Sound:** User testing indicated a need to better incorporate sounds. Efforts should be made to develop and incorporate amusing sounds and other interactive mechanisms, especially adequate and pleasing feedback sounds for the explore screen.

**Interface:** Some of our users were dissatisfied with an aspect of Fitt’s Law: the amount of time it takes to get the pointer to the icon. We should look into how to accelerate the actions. When we lowered the age of the target audience for our product, an unanticipated side effect is that some young kids have trouble with the tiny icons and images. Design efforts should be undertaken to make everything in the kitchen bigger. Also we would look into making the kitchen more explorable in general for young children.

**Graphics:** Suggestions were made to incorporate full color into the screen. Changes in the use of color such as coloring in the background, may increase the challenge for children of identifying the items which are attracting ants.

Features: SCREEN 2

**Passage of Time:** We acknowledge challenges with illustrating the passage of time. Future design iterations should include a more fluid change rather than three discreet states. In the prototype, ant and sky animations are status-based. In the actual application, these changes would evolve more smoothly.

**Back arrow:** The Back arrow should be outlined. Kids didn’t have trouble distinguishing it, but in terms of consistency, it should be outlined.
**Interface**: The Hints button would take on a contextual approach, offering a hint for the highest priority item on the screen to be cleaned up. The graphic interface would be revised to be more explicit in pointing out how many messes to clean up, i.e. how many stars you need to gain to be successful. At the end of the application we would incorporate some sort of message that allows the user to reflect upon their actions.

**Expansions in Functionality**: Several recommendations were received related to functionality of the user interface and user experience. Users asked for more messes to explore, and additional interaction styles for cleanup. They also wanted more things to happen, i.e. more interaction with items within the kitchen (opening of cabinets, for instance). Expanding the role of the little girl character who is the introductory icon is a next generation enhancement. Having her appear in the kitchen window, act as a character in the explore and game screens and provide user feedback would be another element of expanded functionality. Finally, user testing indicates that kids want more levels of challenge. Counters would be incorporated and the noise levels would be perceived as more complex as users move through different levels.

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**PART B: EDUCATION**

**Question 1: Educational Goals**

**Intended Educational Goals**
Simply put, Ants, Ants, Everywhere is an interactive computer interaction intended to produce in children ages 6—10 a cognitive understanding of the consequences of a typical behavior leaving a kitchen messy and becoming infested with ants. The user will develop an awareness of the ramifications of his/her actions by using a setting, scenario, tools and behaviors that are familiar and authentic.

The program's activity reinforces the cause and effect relationship in several ways. Children this age, for the most part, and as verified with our user testing, are familiar with the setting of the kitchen. It is presented in a friendly, hand-drawn style. The real-world scenarios of spilled orange juice, cookie crumbs and left-out cereal bowl are familiar to this target audience. The tools such as mop and sponge are also age-appropriate. As they progress through the program, children learn about the causes—specific properties of certain foods and their attractiveness to critters and also the effects—benefits and drawbacks of certain cleaning tools in an effort to build understanding. In the game activity, they apply their knowledge to trying to clean up a dirty kitchen quickly before the ants overtake it.

**Question 2: Pedagogical Methods**

**Pedagogical Methods and Principles**
The application is based on methods grounded in both cognitive and behaviorist learning principles and methods. It is important to note how each one plays a significant role in the learning functions of this educational program.

Based on cognitive learning theories, the application requires the learner to recognize and construct patterns that allows him to understand the concepts and exhibit cognitive abilities such as reasoning, to figure out how to ward off the pest problem. The user's understanding is gained by active processes of construction as opposed to passive assimilation of information or some type of rote memorization about how, for instance, insects might penetrate areas of the home.

However, the ability for the intended audience to gather and retain significant concepts relies on some form of behaviorist principles as well. Since young children in this capacity may not necessarily have the background knowledge to evaluate the existing concepts of pest infestation, they rely on formation, strengthening and adjustment of associations between the stimuli (what to do with the dirty dish, for example) and the responses (infestation by ants). This is an important mechanism for reinforcement while small units of behavior (for instance, figuring out the basic tools for wiping up a sticky spill) are mastered and used to attack more complex units (such as utilizing their new bank of knowledge to go back and clean the whole kitchen). Maintaining behaviorist views, the application then shapes the student's knowledge and applies rewards (ants retreating when proper treatment is applied, for example) as evidenced in the screen.

Specifically, within the behaviorist social psychology model, the Ants program is designed to operate within the Zone of Proximal Development. Coined by Vygotsky, the Zone is described as one where a user/child operates as an agent for activities but has awareness of an interaction with a more knowledgeable other. In the case of Ants, there is a guide persona, Annie, who is a helper. Jim Greeno explains the Zone further when he describes it as the in-between stage in which a learner grows in understanding. An effective learning Zone has two characteristics: the learner is being stretched (but not too much) and the learner is provided with sufficient scaffolding that offers support needed to traverse the Zone successfully. As the learner traverses the Zone, the scaffolding fades away and the learner will be at a point able to transfer his/her learning to real-world situations.

The Ants program addresses these two characteristics in several ways. The user begins the interaction with an audio introduction that add to the engagement. The ant persona acts as a scaffolding guide accessed if the user needs it. During the first phase of interaction there are pop-up windows that explain some of the causes and effects of the dirty kitchen situation. The activity screens provide clearly placed and designed Hints and Directions buttons that offer support for the user to traverse the Zone. As the learner progresses through the Zone, he/she accesses less scaffolding while being more concerned with trying to do the cleaning tasks faster and more effectively.

Finally, there is an element of situated learning that is clearly at play in the Ants program. As detailed in Cognitive Apprenticeship: Making Thinking Visible (Collins, Brown and Holm, 1991), situated learning serves several
different purposes. First, students come to understand the purposes of uses of the knowledge they are learning. In the design of Ants, learners learn what happens when leftover food is left out. They also come to understand why it is important to pre-empt the infestation of pests. Second, they learn by actively using knowledge rather than passively receiving it. The users of Ants are actively manipulating and interacting with the program. They are not being spoken to or having to read much text. Third, they learn the different conditions under which their knowledge can be applied. By testing out different cleaning tools and the consequences of their actions, users differentiate which strategy is most effective for different situations or settings. Fourth, learning in multiple contexts induces the abstraction of knowledge, so that students acquire knowledge is a dual form, both tied to the contexts of its uses and independent of any particular context. Although the Ants program is limited in scope, it is so specific that the transference of the knowledge to a different setting (kitchens are not the only settings to which ants are drawn) or domain (properties of certain foods like sugar content or fat tie into a study of food and nutrition, for example) is fostered and likely to occur.

Question 3: Reinforcements and Hindrances

Reinforced Goals
The paper prototypes afforded us solid feedback on the setting, visuals and understanding of the scenario. We could test the understanding of the messages and text that were used. Also we could assess the understanding of the cleaning tools cause and effect sequence conceptually. Because we asked the users after testing to express verbally what they had learned and what they thought the learning goals were, we were able to refine (and change somewhat drastically) some aspects of the design to align with the learning.

Hindered Goals
Although our paper prototypes and usability/learning questions yielded some significant feedback in user studies, there were obvious drawbacks. Because we as testers were walking the users through the interaction, they weren't able to be in total control. Pop-up messages were not quickly visible. So we couldn't assess the pace of the activity and accordingly, the learning. For sure we were not able to assess the satisfaction of using the program. That was a huge trade-off. We had to ask detailed questions rather than let the user engage and experience the activity.

Limitations of the interaction techniques, in both the paper and on-line prototypes, hindered the ability to effectively illustrate the concept of time passing and more ants arriving. Although we described this to our users, it was difficult to test their responses and determine what the appropriate time quantities were.

The paper prototypes allowed users more interactivity than the early stages of the on-line implementation, as we could easily arrange the cutouts to illustrate a range of scenarios for the user to interact with. On the other hand, the on-line version was superior for figuring out exactly how the interactions should work, and for providing immediate user feedback.