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Interactive Cause and Effect Comic-book Storytelling for Improving Nutrition Outcomes in Children

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ABSTRACT

Obesity among children and adolescents is increasingly becoming a major public health problem, Poverty and lower socio-economic status as well as lack of parental awareness regarding a balanced diet and adequate exercise all contributes towards high overweight and obesity rates among Latino American children. Access and affordability of smartphones and mobile internet devices provide an opportunity to create nutritional educational interventions that can significantly impact and change attitude and knowledge regarding healthy diet and exercise. In this paper we present the design of a comic book style interactive storytelling mobile application that creates multiple cause and effect scenarios that the child can role play and learn from. The novelty and innovation lies in the design of the application to begin at a clinical setting while requiring completion at home and involving significant participation by the parent and the child.

Categories and Subject Descriptors

D.2.2 [Software Engineering]: Design Tools and Techniques – *decision tables, state diagrams, and user interfaces.*

General Terms

Design, Human Factors, Verification.

Keywords

Serious Games, Games for Health, Obesity Interventions.

1. INTRODUCTION

Recent years have seen a sharp increase in obesity rates among children and adolescents in the United States. The National Health and Nutrition Examination Survey [1] indicates that almost a quarter of preschoolers (2-5 years) and one third of school age children and adolescents are obese or over weight. There are also significant socio-economic and racial disparities evident and Latino children seem to be disproportionately affected by the current obesity epidemic; 38.6% of Latino girls are overweight or

obese compared to 25.6% white girls, the rates are even more alarming at 42.9% among 12-19 year old Latino boys [1]. Childhood obesity has been associated with an increased risk of cardiovascular diseases and Type II Diabetes leading to significant long-term morbidity [12]. Latino children in the United States are currently at the highest risk for developing Type II Diabetes when compared to their white counterparts [13]. Poverty leading to lack of affordability and access to healthy food are some of the major factors that account for high overweight and obesity rates among Latino inner city children and adolescents [14]. In addition, Latino children and adolescents who are highly acculturated to an American lifestyle have poor eating habits with greater dependence on fast food and spend less time on exercise and physical activity [15].

2. RELATED WORK

The idea of combining rich cause and effect scenarios in a healthcare setting is relatively novel and there has not been much precedent. Games, visualizations and simulations have been used effectively over the past decade to help with clinical outcomes and are outlined in [2, 3, and 4]. Specifically games have been really effective in helping with training, whether in surgical settings or to understand workflow and triaging protocols. Majority of the applications have been on the caregiving side of healthcare. Recent research has shown that cause and effect scenarios are an effective medium of learning [5, 6]. Technology, specifically smartphone based interventions have become adoptable over the past few years and their adoption has been discussed in detail in [7] and specifically the use of games in children and adolescents for overcoming obesity is discussed in [8 ,9]. The majority of the discussions on current state of the art in the use of apps and games for tackling obesity among children conclude that the research is not grounded in behavioral change and nutritional content doesn't naturally provide recommendations for daily intake and goal setting. In this paper we outline the design of an interactive cause and effect story that children make choices and get rewarded for their actions. The design used exhaustive nutritional intake recommendations that are conveyed via a comic-book style story

and provides several opportunities for children to replay, view and process the result of their actions.

3. BACKGROUND AND THEORETICAL FRAMEWORK

Interactive Cause and Effect Comic-book Storytelling (ICECS) is a new approach to improving healthy life style with respect to nutrition and physical activity among Latino children. Even though ICECS is developed to improve these outcomes among Latino American children, however the design strategy could be applied to any demographic. It involves developing and testing a bilingual family-based and culturally sensitive educational intervention in an interactive comic-book format. It is deployed on a portable device (touch-based tablet). By targeting both Latino parents and their children simultaneously, this intervention improves knowledge regarding healthy nutrition and exercise and promotes parent-child communication, complements the learning process and improves knowledge sharing. Similar strategies could be applied to larger trials that can be replicated as a relatively brief but targeted intervention incorporating low-cost computer technology. In this exploratory study, patients in the intervention group play the first chapter of ICECS during their hospital visit, and then continue to complete additional two chapters at home to enable them to advance their goals and missions by exploring several cause and effect scenarios with parental assistance and approval; this is facilitated by logging on to a designated mobile-ready site providing the same underlying message regarding obesity prevention.

ICECS focuses on utilization of interactive comic-book style storytelling technology to enhance knowledge regarding healthy nutrition and benefits of instilling good eating habits and daily exercise into obesity prevention. This educational intervention is expected to motivate parents and children (teens) to adopt healthier lifestyles.

The choice of a comic-book style storytelling with many forks and joins in the narrative is specifically chosen since it is a novel medium that is extremely popular among children and adolescents. It is more likely to capture their attention than any other media and can be easily designed for combined play with a parent, thus encouraging shared learning. In ICECS a role-playing superhero (i.e., a graphical representation of an individual within a virtual space) is the central figure that the child controls and the story path taken by the superhero is based on the actions/choices of the child. The superhero acts as a guiding force with the central theme of overcoming several obstacles and completing missions to rescue his parents from an infamous villain. As the parent/child progresses through the story, different scenarios are encountered and different solutions are presented with favorable responses enabling the avatar to move further along/closer to rescuing the parents. A participant may or may not complete every mission at the first try, but will always receive a “reward” for making healthy eating and appropriate physical activity choices. These rewards lead to the superhero getting stronger and powerful to complete the mission and finish the story.

Our hypothesis that such an intervention will enhance knowledge is based on recent studies that have explored how avatars may influence individual behaviors [10]. Researchers at Stanford have started to explore a concept they have labeled the Proteus Effect [16]. The Proteus Effect is a hypothesis postulating that the behavior of an individual conforms to implicit cues provided via a

digital self-representation i.e., superhero; For example, research suggests that if an individual’s avatar is created to be taller, this individual acts more confident during negotiation tasks [16]. In other research, individuals that viewed an avatar of themselves running on a treadmill were more likely to exercise than randomized to a non-exercise condition [17]. Based on the Proteus Effect, actions of an avatar, (particularly avatars constructed to look like the individual), can act as a model for an individual’s behavior. Previous research from social learning theory has highlighted the power of modeling for skill-building, behavior change, and shifts in self-identity [11]. In theory, an avatar may be a particularly powerful mechanism to explore for promoting new skills, behaviors, and possibly even self-perceptions - all key tasks for promoting positive behavior change. ICECS combines the fundamental principles of play therapy with cognitive behavioral therapy and develops an interactive intervention for creating a change in knowledge and attitude among Latino children and adolescents with respect to eating a healthy diet and regular exercise for optimum future growth and development. A future study would assess whether this knowledge gain actually translates to a change in behavior from a virtual world to a real world.

4. METHODS

4.1 Needs Assessment Survey

The purpose of the Needs Assessment Survey was to develop a web-based bilingual (English/Spanish) survey of Latino parent-child dyads visiting an inner city hospital or clinic to assess their dietary habits and exercise patterns. Although we had initially planned to recruit 25 parents for the survey, the response that we had from the parents, the ease and efficiency with which it was implemented encouraged us to gather data on 102 parent/child dyads over a 14-week period. We feel this strengthened the conclusions from our survey and helped us better understand the dietary habits and exercise patterns in our target population.

Sample Inclusion Criteria (Patient/Parent):

- Patients of Latino ethnicity, 8 to 15 years of age who register in the pediatric ED and patients who visit the three Family Learning Centers (FLC) and are accompanied by a parent/guardian who is 18 years or older and able to communicate in English or Spanish
- A patient must receive an Emergency Severity Index (ESI) Version 3 score of 4/5 indicating non-urgent status for recruitment in the pediatric ED.

Sample Exclusion criteria (Patient/Parent):

- Medically unstable patients, patients with ESI score of 1-3 (life threatening medical/surgical condition).
- Incarcerated patients or patients from juvenile detention facilities.

Recruitment was done at the Pediatric Emergency Department (PED, only non-urgent patients were included), Pediatric Ambulatory Care Clinic (ACC), and the Family Learning Centers (FLC). Information from this survey was used for intervention development; key attributes (e.g. risk awareness, facilitators, belief, barriers, acculturation and peer norms) were used to refine ICECS scenarios making it culturally appropriate. The cross-sectional survey was conducted over a 14-week period. Prior to implementation, pilot testing was conducted and the survey

optimized. The survey was deployed on a touch screen tablet PC (in PED) and on a desktop PC (in ACC and FLC). Figure 1 shows how the surveys were administered.



Figure 1a. Family Learning Centers used for the survey

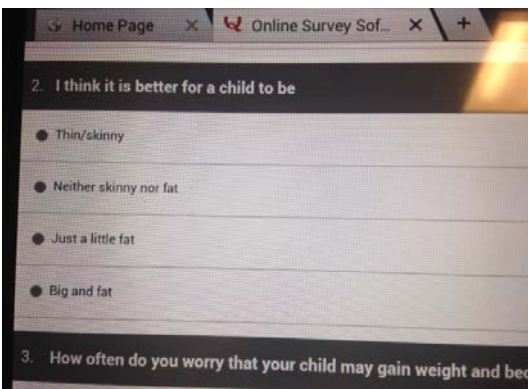


Figure 1b. Bilingual survey on iPad (touch screen) used for participants in the pediatric ED

A total of eighty-two responses were collected between December 2013-March 2014. Forty-four (53.6%) responses were from PED, 22 (26.9%) from the FLC and 16 (19.5%) were from the Pediatric ACC. Majority (33%) of respondents were between 25-34 years and 72% were females. All participants were Hispanic (target population). Most parents (41%) were less than high school educated. Mother (83%) was the key person making food choices for the family in most households. Most parents (81%) considered a healthy body image to be “neither skinny nor fat”. Most (62%) were aware that obesity was related to problems like low energy, low self-esteem and poor social acceptance and almost all (98%) agreed that it could lead to diseases like diabetes and heart problems. Parents felt that they could help their children by: making healthy food choices for them (78%), and eating healthy themselves (72%). The main barriers to healthy eating included lack of full control over their child’s diet (59%), time constraints (23%) and child’s own food choices (31%). Lack of knowledge regarding healthy foods was the least cited barrier. Food as a reward is not frequently used in Hispanic households and in most Mexican American homes meals are eaten sitting together around the table (85%). Majority (74%) of those surveyed said that vegetables were included in at least 1-2 meals consumed. 47% said that they served juice or other sugary drinks with their child’s meal at least a day. Ethnic Mexican American food was also frequently served in most households (41%, daily). Overwhelming majority (86%) of parents acknowledged importance of physical activity for their children. School based sports activities formed

an important part of physical activities. Lack of parental time (20%), environmental reasons (38%) and safety of outdoor play areas (30%) were some the reasons cited as barriers to play.

4.2 Storyboard development

For development of content specific to ICECS, a nutritional specialist working in our patient community for the past several years with valuable experience in conducting educational workshops pertaining to healthy diet and nutrition targeted towards the Latino population was recruited. The design of the story was based on a multiple story-line multiple ending narrative that was dependent on the food and activity choices made by the child. The plot was chosen to be simple and context sensitive. The main character realizes that his/her parents have been kidnapped by an evil villain and he/she now needs to transform into a superhero and go on a rescue mission. As every superhero needs help from the world around, you the player have to help the superhero complete his/her mission. The superhero needs to eat healthy, eat balanced and eat on time. The super hero also needs to perform the correct exercises and activities to stay healthy. The narrative then breaks several times during a day long mission to ask the child to assist the superhero and make the appropriate choices. Depending on the choices the player makes the story can have many different endings, however only the healthy choices lead to a successful completion of the mission. ICECS effectively employs rich narrative with compelling endings to add replayability and test multiple scenarios in a cause and effect setting. Over several iterations of interacting with the story the player builds knowledge on what foods are healthy and balanced and what activities promote physical activity. Figure 2 shows the early morning breakfast narrative where the player is recruited by the superhero to help prepare a balanced breakfast.

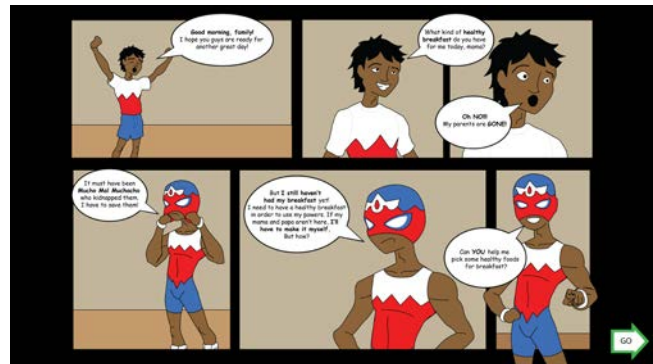


Figure 2. The breakfast storyline for the morning mission

The Child starts at the breakfast level in the hospital and upon successful completion is given a code to play the remaining storylines at home. Parents reward the child by giving them meaningful real-world prizes as they complete the missions at home.

4.3 Nutrition and Activity choice lists

ICECS is designed to help children and parents understand what good food and lifestyle choices are, and how they can apply them to their lives. It is designed with the intent that after completion, the child should understand:

- How to choose foods and make a balanced meal (tailored to each meal – breakfast, lunch and dinner)

- Which foods are healthy, and which foods / types of foods to avoid
- How to choose good alternatives to bad food choices
- The importance of eating well, and exercising to stay fit
- How to incorporate exercise and fitness into their everyday lives
- Ideas for exercise and healthy meals

Two master lists were developed by a nutritional specialist, the list contained three foods when combined together were given a remediation message and a score. The mission is marked to be successful only if the combined score reached a particular threshold. Four distinct narratives were developed based on the score obtained with one of them leading to a successful mission. Table 1 shows a snapshot of the nutrition master list while Table 2 shows the activity master list. The tables show the different scores the player can get in the first column (scores can range between 1 and 4), 1 always indicates a winning score and the result will be a successful mission and the child will progress to the next storyline in the comic book. The child always selects three food groups to create a balanced meal and three activities that are appropriate for the time of the day and can easily be executed. The explanation provides remediation message on the selected choices and their effect. The child then gets a chance to replay by selecting new choices until a winning combination is chosen.

Table 1. Snapshot of the Food Master List for Breakfast

S	Food 1	Food 2	Food 3	Explanation
1	Oatmeal - One cup - 150	Apple One - 50	Skim Milk - one cup - 100	Good Job, this is a great breakfast!
1	Raisin Bran Cereal - 150	Banana - one - 100	Skim Milk - one cup - 100	This breakfast will keep you healthy!
2	Flour Tortilla - 150	One Scramble Egg - 125	Green Grapes	Needs to be a whole wheat tortilla
2	Pancake - 100	Peanut Butter - 90	Banana - 100	This breakfast will keep you healthy!
3	Apple Juice - 120	Flour Tortilla - 150	Cheddar cheese - 100	Wait a minute, should have an apple instead of juice
3	Monster Energy Drink - 115	Mozzarella Cheese Stick - 80	Peanuts - 400	Energy Drinks are not healthy, have Skim Milk instead
4	Granola - 500	Pear - 50	Two Percent Milk	A better choice would be skim milk and Raisin Bran cereal
4	Fruit Smoothie - 130	Raisins - 130	Donut - 200	Not a good choice, donuts are high in sugar

Table 2. Snapshot of the Activity Master List for Morning

S	Activity 1	Activity 2 2	Activity 3	Explanation
1	Jog in Place	Do Push Ups	Jump Rope	You can easily do this before you leave to school
3	Walk with a	Watch Television	Play on the	Not the best effort, sitting in one place is not good

	family member		computer	
4	Take a nap	Sit at the kitchen table	Text a friend	Not enough exercise before school

4.4 Story Progression

Each mission has three primary states: story, gameplay, and results. During the story state, the user will be shown a comic strip that depicts the current segment of the story. Afterward, the user will begin gameplay, during which the user will make decisions for the superhero, ranging from what foods the hero should eat for breakfast, to what activities the superhero should perform before he/she leaves the house. Once the child has made his/her decisions, see Figure 3, the story will manifest into a narrative based on their actions (this is another story panel, not the results screen, where the multiple narratives get forked). Note: if the user made good decisions, the story will progress well; however, if poor decisions were made, the superhero may have a hard time completing his/her mission and have to repeat the previous stage. Lastly, the child will be shown their results, see Figure 4, which informs the child which of their choices were good, and which choices should have been avoided. As shown in Figure 4, even though individually the selected choices are healthy, together they do not constitute a balanced meal.

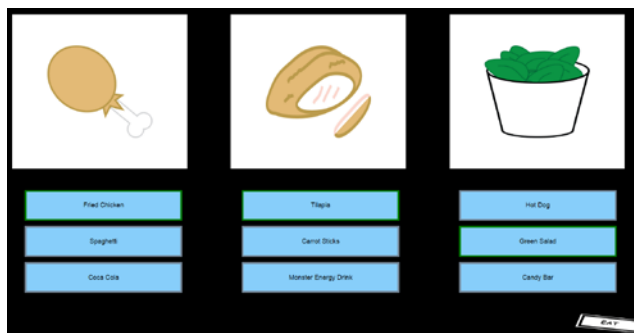


Figure 3. Choice selection screen

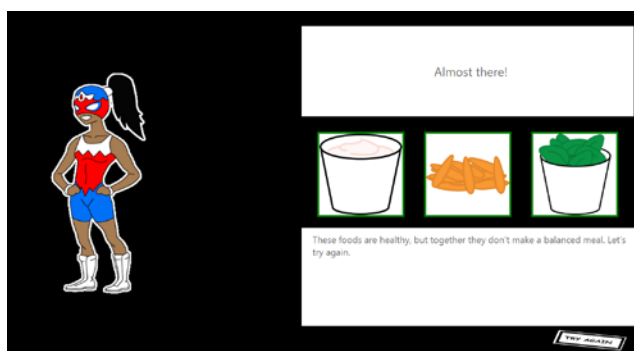


Figure 4. Results screen

If the child does well, in terms of making the right food and exercise choices, he/she will be able to progress to the next chapter in the story. Otherwise, he/she will retry the game (this time with different choices than before) until the user chooses a winning combination. Figure 5 shows the game progression and interaction sequence.

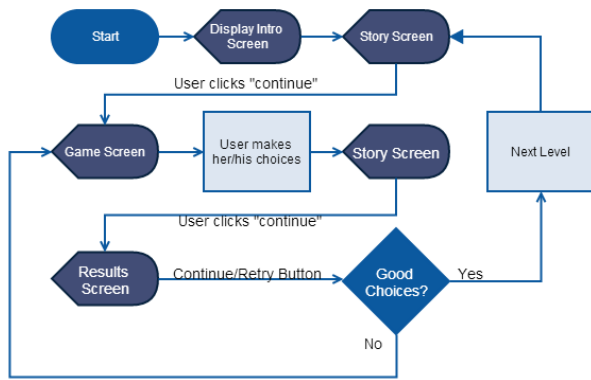


Figure 5. Story progression and interaction sequence

4.5 Usability testing

Observations were made by a research assistant during the usability test and Table 3 shows the problems and the measures taken to correct them.

Table 3. Usability issues and corrective measures

	Problems identified	Corrective measures
Readability	Users had problems with reading all upper case letters and font sizes.	Adjustment of font size and case of dialogues on screen to make script easily readable
Navigation issues: Lengthy video game strips	Users especially younger children struggled to read through comic strips that were long and skipped portions	Video game story strips separated into smaller frames so that all the portions are not displayed on the single screen.
Pretest survey	Pretest survey at the start of the video game distracted the child user	Pretest survey removed from the videogame
Language choice for play	Difference in language choice between child and parent was observed commonly	Providing parent and child with two tablets could be considered
Child and parent combined play	When given the choice to pick a healthy meal in order to advance in the game, kids would ask the parents for help at this point and both	<u>Positive observation:</u> Encourage child/parent combined play

	would briefly work together to pick out a balanced meal	
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A modified version of the software usability scale [cite], was created specifically to work with ICECS. A 7-point scale that ranged between strongly agree and strongly disagree was created for the following 9 questions and parent/child dyads in FLC were recruited for the test:

1. Overall, I am satisfied with how easy it is to play the game
2. The instructions were clear and easy to read
3. I was able to understand the controls and make progress
4. I was able to master the controls after repeated use
5. When I made a mistake, I was able to easily correct it
6. The information presented was pleasing and readable
7. I valued the knowledge conveyed by the game
8. In future visits, my child and I would like to replay
9. I would recommend using the game to my friends

5. DISCUSSION

This is the first study where a bilingual videogame intervention was tailored to a specific Latino ethnicity target population group and the videogame was designed for both parent and child play. Our pre-videogame assessment survey provided us with insights into the dietary patterns and attitudes towards food and exercise that are prevalent among Mexican American parents. Based on this information and experience of our clinical research team, we tailor made the videogame intervention using food choices that were specific to this population. It is increasingly being realized that chronic disease conditions that begin in childhood and factors contributing towards it should be understood from a social and eco-bio-developmental framework. In this conceptual framework, the child is nested within the family microsystem, that thrives within the community and a larger societal ecosystem. Better understanding of this ecosystem is necessary to devise interventions that impact the overall health and well-being of the child.

After identifying and fixing several issues via usability testing the final version of ICECS is now ready to go into clinical trial and perform the intervention both at the hospital and at home for 150 parent/child dyads.

6. CONCLUSION AND FUTURE WORK

We have presented a novel approach to designing a comic-book style interactive intervention administered to parent/child dyads at a pediatric emergency hospital and also at home with the aims of improving nutritional and physical activity outcomes. This is the first intervention to involve both parent and child to actively participate and communicate while interacting with the story and the missions developed. We have seen successful results in limited focus group and usability testing stages and hope to report comprehensive findings once a clinical trial involving 150 parent/child dyads is completed.

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