From Paper to Pixels: A Usability Study of a Tsunami Safety E-Booklet

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Abstract: More people have died in Hawai'i from tsunamis than from hurricanes, floods, and volcanoes combined, making it our State's most deadly natural hazard. For tsunami education to be effective, especially in younger audiences, learners must be engaged through multiple modalities. To help meet this need, a printed tsunami safety booklet has been modernized to an e-booklet format. Using a turtle superhero as a guide, the Hawaii tsunami safety e-booklet (http://bit.ly/tsunamilayout) helps educate 3rd through 5th grade students about tsunami hazards, preparedness, evacuation, warning, and risk. A research study was designed to evaluate the content, effectiveness, and user satisfaction of the interactive e-booklet through iterative usability testing. Two rounds of testing were conducted face-to-face and through Google Hangouts on Air where participants "thought out loud" as they explored the e-booklet content. Additional feedback was captured asynchronously through a survey link on each page of the e-booklet. A post-study captured additional attitudinal data. Changes were made to portions of the e-booklet focusing on the participants' recommendations which included immediate audio and visual feedback, increased control over multimedia, personalization, and gamification. Feedback from the second round of usability testing indicated that improvements made to the e-booklet augmented the overall user experience.

Introduction

Since Hawai'i is situated in the middle of the Pacific Ocean and surrounded by the plate tectonic activity associated with the Ring of Fire, our island paradise is extremely vulnerable to distant tsunamis generated by earthquakes thousands of miles away. In addition to the threat of distant tsunamis, the Hawaiian Islands are located over a hot spot of volcanic activity, a region where locally-generated tsunamis can be created. Tsunami education is a critical component when taking steps towards increasing the resilience of a coastal community. Without public understanding of the tsunami hazard and the procedures in place for a tsunami event, communications and effective and timely evacuation may breakdown, ultimately resulting in loss of life. For tsunami education to be effective, learners must be engaged through multiple learner modalities (Metiri Group, 2008).

To help address the tsunami education gap, the National Oceanic Atmospheric Administration (NOAA) Pacific Services Center and its partners developed a printed tsunami safety activity booklet. The booklet's vocabulary and activities are geared towards grades 3 through 5, however much of the content may be understood and enjoyed by students in lower grades. The content is broken down into two primary categories: learning and activity. The learning elements will introduce key tsunami safety concepts and the activity section will reinforce the concepts and provide opportunities to personalize and connect with the topic. Throughout the booklet are No Ka 'Ohana (for the family) activities and Tsunami Superhero Challenges which encourage students to engage with family and guardians on key tsunami safety topics. The printed booklet was finalized in December of 2010 and was distributed as an insert in the April 1st edition of the Honolulu Star-Advertiser from 2011-2013 during April's tsunami awareness month. While there has been positive feedback from distribution through the newspaper insert and various outreach events, the annual publication cost was not sustainable. In addition, the distribution of the booklets to elementary schools in the tsunami evacuation zone was logistically difficult given limited personnel and financial resources. Moreover, the effectiveness of education is increased when verbal and written information is frequently disseminated from multiple sources over multiple communication channels (National Resource Council, 2011).

In the fall of 2013, the researcher began the conversion of the existing printed tsunami safety booklet to an e-booklet optimized for web and iPad delivery. There was initial hesitation to convert the booklet into an electronic format. Fears about lack of digital access to the e-booklet in the classroom were generally unfounded given the results of a 2013 Technology Readiness in Schools, Status and Readiness survey. It found that 100% of responding Hawaii schools (n = 52) had access to a computer laboratory, 96% have computers in their classroom, and 81% had tablet devices in their classroom. The e-book was developed using a rapid prototyping model with two rounds of usability testing. The purpose of this research study was to evaluate the content, effectiveness, and user satisfaction of the interactive e-booklet through two rounds of usability testing.

Methodology

Module Development

The e-booklet was developed using Articulate Storyline, a rapid e-learning authoring software. Storyline was chosen for its ability to build highly interactive online and mobile modules with the ability to publish to multiple formats (HTML5, Flash, and iOS). For the first prototype, the researcher imported the digital layout of the printed booklet (Figure 1, left) into Storyline, but quickly discovered the need to reformat the newspaper insert portrait layout (http://bit.ly/tsunamisafety) to a landscape orientation to accommodate the iPad output format (Storyline's iPad player only has a landscape output option). In addition, the smaller output size of the iPad screen meant that most of the text was too small and therefore the entire layout needed to be redone. The researcher used the assets from the InDesign file used to create the printed tsunami booklet to reformat the text and graphics for the iPad screen. The increased text and graphics on the smaller output screen of the iPad meant the overall content had to be spread out over more pages. To limit the

overall length of the e-booklet, the researcher decided to hone down the text and graphics to key tsunami safety topics. After an internal edit, the text went through an external review of tsunami content experts, and the condensed text was given to the researcher to begin the conversion process. Subsequently, the text, graphics, videos and interactivity were assembled to create a second (Figure 1, middle) and third prototype (Figure 1, right) optimized for web and iPad delivery.

Figure 1. Page 2: First prototype (left), second prototype (middle), third prototype (right)

Population

The participant target population was elementary educators in Hawai'i. Participants were contacted and recruited via email through an existing database of elementary educators throughout the state of Hawai'i. A short demographic pre-survey was administered to identify participants that met a varied audience profile. Interested participants that did not undergo usability testing interviews were given access to the module on their own and could provide targeted feedback through a survey accessible from a link embedded in the e-booklet.

The participants for this usability study included elementary teachers and an elementary science education specialist. They had a range of technology expertise, a diverse geographic distribution (O'ahu, Kauai, and Molokai), and their students used a variety of devices in the classroom (PC, Mac, and iPad) on a variety of browsers (Firefox, Chrome, Internet Explorer, and Safari). The first round of usability testing included four participants: a third/fourth grade special education teacher, a second grade teacher, a fifth grade teacher, and a primary science specialist with experience in Native Hawaiian culture. The special education teacher was selected to give insight into how the e-booklet could be appropriately targeted for a range of student abilities. The second and fifth grade teachers were chosen to encompass feedback from the lower and upper end grade range of the target audience. Finally, the primary science specialist's perspective was solicited given her experience with a range of grade levels and her Native Hawaiian culture lens, which has a heavy emphasis in the fourth grade.

The second round of testing also included four participants. There were two repeat individuals from the first round: the third/fourth grade special education teacher and the second grade teacher. These repeat participants were specifically chosen so they could provide insights into the module changes implemented between the first and second round of testing. The second round also included two new participants: another second

grade teacher and a third/fourth grade teacher. While all the other participants participated in the testing virtually, the new participants were face to face and used an iPad to access the e-booklet.

Usability Testing

The usability study was conducted in two rounds with four participants in each cycle. In the first round, all usability tests were conducted through private Google Hangout on the Air sessions. Using Bergstrom's Concurrent Think Aloud (CTA) and Concurrent Probing (CP) methods, the researcher asked the participants to verbalize any thoughts, concerns or questions on each page of the e-booklet, while being reminded to move their cursor to where they were looking on the page. While discussing their perspective, participants were also asked to role-play their students' point of view. Given the interactive nature of the e-booklet, the researcher continually probed the participants about what they thought was clickable and why they clicked on certain items. Participants went through the entire interactive e-booklet, which included a title page, an introduction/directions page (Figure 1, middle), 13 content pages, and a concluding certificate page. At the conclusion of the interview, the participants were given a post survey where they answered Likert-scale attitudinal questions about the e-book content, effectiveness, and user satisfaction, and open-ended questions about their overall impressions and suggested improvements.

At the conclusion of the first round of interviews, all of the recordings were transcribed and each distinct comment was entered into a spreadsheet where it was tagged by page number and coded accordingly. After a thorough analysis of the five most commented on pages, the researcher focused attention on making changes on three pages (Be a Tsunami Superhero, Learn About Tsunamis, and Make an Emergency Kit) based on their content importance to the overall e-booklet and to address high priority issues mentioned by the participants.

The second round of usability testing followed the same protocol as described in round one for the two new participants in the study. The new participants conducted the survey face-to-face using an iPad. The two repeat participants conducted the interviews through Google Hangout on the Air sessions and were asked to focus their attention on the three modified pages (Figure 1, right). The recordings for these interviews were transcribed, tagged, and used to make future modifications to the e-booklet.

Technologies

Usability interviews done remotely were conducted through Google Hangouts on Air. The participant would use their personal computer to navigate to the web site of the prototype and share their screen with the researcher. Hangouts on Air automatically recorded the session and stored it privately on the researcher's YouTube channel. Face-to-face participants were provided with an iPad to go through the prototype. The researcher took notes during the session and the audio was recorded using a cell phone voice recorder. In addition, Google Hangout on Air recordings were designed so that no identifiable information other than the interviewee's voice would be evident. The demographic pre-survey and attitudinal post-surveys for usability participants were

administered through Google Forms. Other participants who wanted to review the module, but did not have time to participate in the usability study provided targeted feedback through a Google Form as well.

Results

Quantitative Results

The post-survey general questions about the e-booklet were rated on a five-point Likert-scale, with one being strongly disagree and five being strongly agree. The mean scores after usability tests in round 1 and round 2 (Figure 2) the following categories:
- understandability: "the e-booklet was clear and easy to understand"
- length: "the length of the e-booklet was appropriate"
- difficulty: "the level of difficulty was appropriate for a 3-5th grader"
- content: "I learned a lot about tsunami safety"
- logical: "the e-booklet flowed in a logical manner"
- visual appeal: "the e-booklet was clear and visually appealing"

 The post-survey questions about the usefulness of the e-booklet's interactive components were rated on a five-point Likert-scale, with one being strongly disagree and five being strongly agree. The mean scores after each round of usability tests are shown for the interactive features of videos, games, quizzes, vocabulary, and personalization.
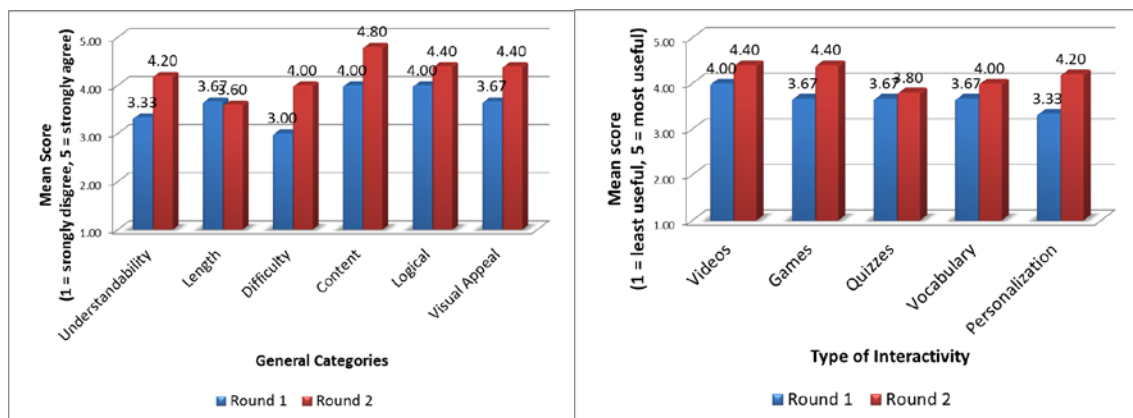

Figure 2. Mean scores for usability post-survey

Qualitative Results

At the conclusion of each round of usability testing, all of the recordings were transcribed and each of the 180 comments were entered into a spreadsheet where they were tagged by page number and coded accordingly. The comments encompassed those that were transcribed by the researcher from the usability interviews and those from non-usability participants who provided targeted feedback. Codes were divided into the following categories: needs edits, clearer directions, praise, auditory feedback, visual feedback, increased control over multimedia, personalization, gamification, and level of difficulty.

- "Needs edits" included spelling, grammar, an image out of place, missing text, etc. and were addressed for the entire booklet.
- "Clearer directions" described the need for a more thorough explanation of the task on a specific page.
    - Figure 1 Middle: "too many things to click on this page… not sure what to do first").
- "Praise" denoted comments that were positive or congratulatory in nature.
    - "I like the tsunami animation… it would grab a child's attention."
- "Auditory feedback" addressed the need to include voice or sounds
    - Figure 3: "give a sound for correct, ding, and incorrect, eh, answers").
- "Visual feedback" suggested the need for additional images or video
    - "I need feedback on it… X on wrong ones, Circles on correct ones."
- "Control over media" referred to having the ability to play, pause, and/or stop audio or video elements
    - "How do I make the siren stop."
- "Personalization" described the ability to add one's name to certain pages to give a sense of ownership
    - "Can I print the certificate with my name."
- "Gamification" referred to the application of game elements such as points
    - Figure 3: "what's my incentive to click on things."
- "Level of difficulty" included that the activity was not at the right level for a given audience.
    - "I couldn't get the backpack right… that one was hard."

As discussed previously, the post-survey also contained open-ended questions about participants overall impressions and suggested improvements, which overlapped with many of specific comments.

Analysis of Results

Quantitative results showed the biggest gains (Table 1) in three general categories: difficulty gained 1.00 or 33%, understandability gained 0.87 or 26%, and content gained 0.80 or 20%.

Table 1. Mean scores after each round of usability testing

	Round 1	Round 2	Total Change	% Change
Difficulty	3.00	4.00	1.00	33%
Understandability	3.33	4.20	0.87	26%
Content	4.00	4.80	0.80	20%

Note. Values represent Likert scale scores ranging from 1 to 5

As discussed previously, I focused my attention on making modifications on three pages (Be a Tsunami Superhero, Learn About Tsunamis, and Make an Emergency Kit). Figure 2 showed modifications made between the first and second round of usability tests on the Learn About Tsunamis page. Figure 3 shows the modifications made to the positive feedback dialog box: the addition of a proud turtle to show the correct response (visual feedback), an audio sound denoting a correct answer (auditory feedback), and an updated points score (gamification). The gain in the difficulty category ("the level of difficulty was appropriate for a 3-5th grader) was likely due to these changes. Other major changes included the addition of clickable vocabulary terms that were read aloud (auditory feedback) and written and verbal hints from the tsunami superhero turtle such as "remember to look at the blue vocabulary words for clues" (visual/auditory feedback). I would hypothesize that the gain in the understandability score was tied to these modifications.

Although quantitative data was not collected, I observed that participants spent longer times on each modified pages exploring the increased interactivity. This may have played a role in the overall gain in the content score since they were exposed to the tsunami safety content for longer periods of time. Not surprisingly, the length score (Round one: 3.67, round 2: 3.60) remained relatively flat since the removal of content could not be undertaken without approval from the content experts.
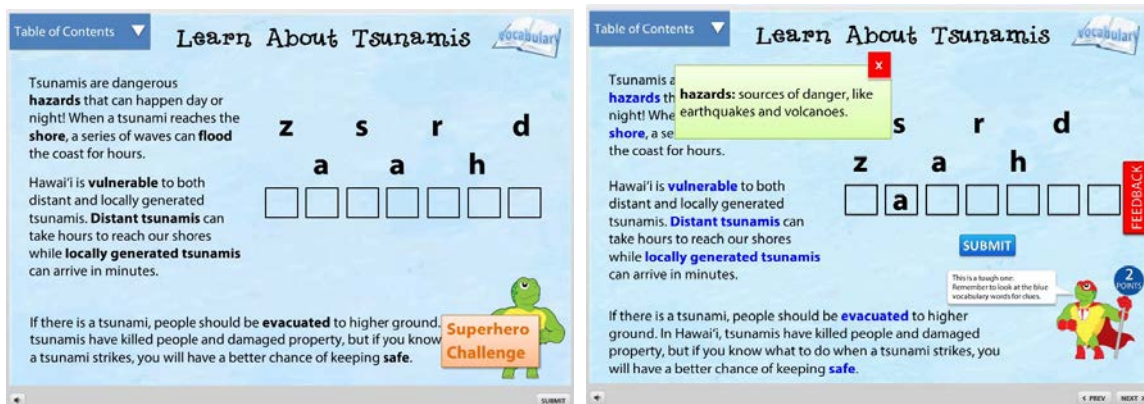

Figure 2. Page 4: Second prototype (left), third prototype (right).
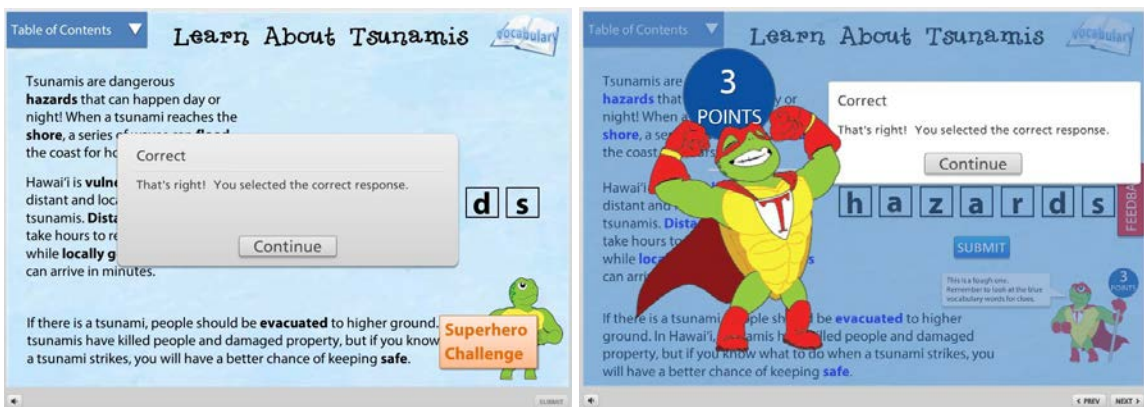

Figure 3. General feedback: Second prototype (left), third prototype (right).

Implications or Discussion

Converting a printed booklet to an e-booklet proved to be a more difficult task than initially planned. However, iterative usability testing helped to identify issues on various scales. Minor edits could be addressed immediately after the study, while larger issues could be systematically prioritized, chunking a large task into manageable pieces.

While cost savings was the primary driver for the conversion, the researcher hopes that the e-booklet format will provide additional value to the printed format. Jones and Brown (2011) found that elementary school students indicated a preference for the conveniences associated with e-books that included pop-up definitions, pronunciation of words, and the option of read-aloud narration. All of these conveniences were added after the first round of usability testing and were well received during the second round of comments. In the words of the participants, the addition of immediate audio and visual feedback, increased multimedia control, personalization, and gamification made the e-booklet "more fun and interesting" because it had "more interactivity."

There were limitations to the study. The recurring negative feedback from both the quantitative and qualitative results was in regards to the excessive length of the e-booklet. Unfortunately, this issue was outside the scope of this project given the lengthy approval process needed to trim content. Another limitation was that it wasn't yet tested with the actual target population. If given additional resources, I would conduct a study of the printed booklet and e-booklet that would compare ease of learning, efficiency of use, memorability, and user satisfaction between the two products.

Conclusion

Based on historical and scientific data, scientists agree that it's not a matter of IF, but WHEN the next destructive tsunami will occur, and we may be overdue. Elementary school students are key in getting the tsunami safety message out to their family. This usability study has gone a long way to make an e-booklet more interactive and relevant for today's digital natives, young students comfortable with technology. In the future, I hope to use lessons learned from this study to carry out usability testing directly with students and their 'ohana to make the e-booklet suitable for intergenerational audiences. On a broader scale, many pedagogically sound, innovative educational materials have been developed for print. Articulate Storyline and other rapid e-learning authoring software allow instructional designers (without a programming background) a means to bring these materials into the 21st century through formats such as interactive e-booklets.

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