Social Reader: a Cognitive Stimulation Approach towards Helping Dyslexics

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ABSTRACT

This research defines a 'Social Reader' aimed to help reading by dyslexia patients. Social Reader is capable of creating a socialized reading environment, where individuals with dyslexia can seek help from volunteers and other readers while reading e-Books, papers, and novels. The help can include an explanation of an equation, a page, or a whole chapter. By implementing the dynamic help between volunteers and readers or just among the readers, a vivid reading community can be established. This well-structured reading community is assumed to help individuals with dyslexia improve their cognitive performance while simultaneously building up their self-esteem and self-confidence as they interact with other individuals with dyslexia. Having low self-esteem is known to severely affect reading, writing, and organizational skills as well as overall life satisfaction for individuals with dyslexia.

The research focuses on three usability engineering methods that assisted in our design. The first method, sensitive persona, captures the empathy of the target user's persona; it can foster the designer's desire to design high quality products for end-users. The second method, persona self-guided evaluation, brings the application of persona in user centered design not only to design but to evaluation, in order to minimize the gap between target users and evaluators when two different groups are employed. The third method, persona think-aloud evaluation, enhances the traditional think-aloud method for user-centered evaluation.

By designing Social Reader, design team members undertook a complete human-centered product design and evaluation life-cycle, including contextual inquiry and analysis, persona creation, wireframe creation, and prototype creation. In each phase of the design process, the concept of a persona was extensively used; in particular, our persona-based evaluation during wireframe and prototype creation.

In designing the Social Reader for individuals with dyslexia, the design team identified sensitive persona centered design and evaluation, connecting it with the goals of Kansei and with affective design. An expert evaluation by usability engineers gained a good projected acceptance for individuals with dyslexia.

Keywords

Affective Design, Persona, Wireframe, Prototype, Dyslexia

INTRODUCTION

Dyslexia is a learning and reading disability, which compromises a person's fluency or comprehension accuracy in his or her ability to read, speak, spell, and organize. Dyslexia approximately affects 4% - 10% of U.S. populations (Blau et al., 2009). People with dyslexia have trouble learning the order of letters in words, associating sounds with letters, distinguishing individual words, and integrating the meaning of different words. Dyslexia can be either present at birth or can be caused by severe brain injury. There is not a known cure for dyslexia. Most of the existing intervention measures aim to improve the reading, writing, and spelling capability of individuals with dyslexia.

Dyslexia is thought to be due to impairments in the representation, storage, and/or retrieval of speech sounds (Carter et al., 2009). Research shows that visual language such as using colors to represent words is useful in improving reading performance of individuals with dyslexia (Genesee et al., 2004). Visual representation of words is believed to be able to facilitate the neural integration of letters and speech sound, lack of which universally exists among dyslexia patients (Blau et al., 2009). Auditory feedback (e.g. text to speech) also demonstrates an increase in the dyslexia patient's reading accuracy in terms of comprehension and decoding (Carter et al., 2009). Auditory and articulatory training can help improve the phonology of individuals with dyslexia (Joly-Pottuz et al., 2008). Computer assistance instructional programs such as reading, writing, and translation assistance programs are also known to help improve phonemic awareness, phonemic decoding, reading accuracy, rapid automatic naming, and reading comprehension (Torgesen et al., 2010). The symptoms related to dyslexia are shown in Figure 1.

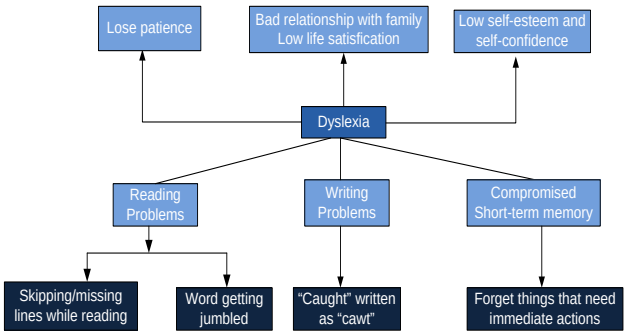

Figure 1-Dyslexia & its effects on a person

In this research, we planned to develop a social reader, which aims at helping individuals with dyslexia read books, make social engagements with friends, and interact with other readers. It is assumed here that through social engagements, individuals with dyslexia can become more engaged and involved in reading books; particularly books which they find difficult reading alone due to the reading disability.

As discussed in the literature described previously, it is known that dyslexia is not solely a physical disease. Cognition, emotion, and behavior are important facets of dyslexia, because low self-esteem and low self-confidence are widely reported, as seen in Figure 2. Treating reading disabilities by oneself does not always obtain the best results. By improving the reading and other performances of the individuals with dyslexia, presumably through social engagement, both their cognition and reading difficulties should reduce. *Social Reader is designed to not only help individuals with dyslexia improve their reading but also their cognitive performance*. For achieving these design goals, several new methods, such as sensitive persona, persona self-guided, and persona think-aloud evaluation methods, were introduced along with the reading community. These methods were thought capable of transforming target users' emotional and affective components into a design process, which is fundamental to Kansei and affective design (Jiao et al., 2006, Khalid, 2006, Swindells et al., 2007).

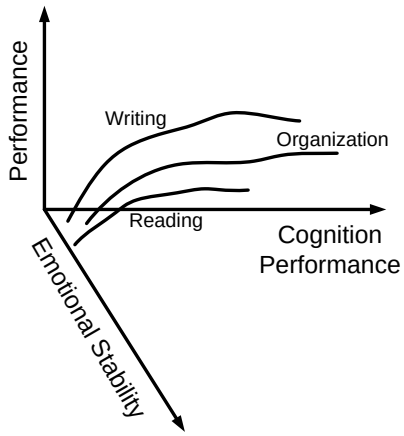

Figure 2- The hypothetical relationship between cognition performance, emotional stability, and reading, writing, and organization performance of individuals with dyslexia

To address these needs, we developed Social Reader, an iPad application that can be used in slate-like devices like Amazon Kindle. Most of these devices are solely being used for reading purposes.

The Social Reader application was developed in three difference phases. In the first phase, the design team created a persona. The persona was not only used as a communication tool, as illustrated by previous research, but was also used as an innovative evaluation tool. The second phase was contextual inquiry and analysis, also known as the analysis phase. In this phase, the design team tried to understand the scope of the problems faced by individuals with dyslexia. Through this phase, the design team gathered the requirements for the Social Reader. Persona self-guided evaluation method and persona think-aloud evaluation method were employed to evaluate the Social Reader wireframe and prototype, which was phase 3 and phase 4 respectively.

Methods

Phase 1: Sensitive Persona – a Source of Cognitive Stimulation for Designers

A persona is a fictional person, an abstract representation of a person, or a user archetype. It is a representation of a hypothetical person (McGinn and Kotamraju, 2008). It can be used to attain the targeted users' goals, needs, and constraints. It also can be effectively used as a communication agent within the design team. Most importantly, a persona can be used as a source to inspire creative design (Triantafyllakos et al., 2009). Before it was formally defined as a theory, personas had often been used by marketing people, who attempted to categorize the market into numerous representative groups (Pruitt and Grudin, 2003). Persona as a theory was formulated by Cooper in 1999 (Cooper, 2004). Personas have been successfully used by various projects such as Microsoft MSN messenger (Pruitt and Grudin, 2003), user centric game design (Brandt, 2006),

E-commercial business (Nielsen, 2004), Cisco public poster presentation (Nieters et al., 2007), European country elderly adults safety and health (Nunes et al., 2010), and mobile OS UIQ (Ronkko, 2005).

Personas were reported to have failed to help design teams achieve their design goals because of lack of good integration to the design team (Blomquist and Arvola, 2002). The lack of knowledge of a persona and low level of motivation can make it difficult for designers to integrate the persona to the design process. Designers' motivations to use personas in their design flow is a key for the successful use of persona.

Empathy design of persona can be incorporated into the persona design to address designer's lack of motivation to use personas and also increase the designer's motivation for a high quality design. Empathy design of a persona is reflected by a persona's figure with emotional as well as environmental contexts, as shown in Figure 3. The environmental context can enhance the sense of loneliness, hopelessness, or helplessness of the target user, which is assumed to be able to stimulate the designers to pursue a dedicated and outstanding design for the patients.

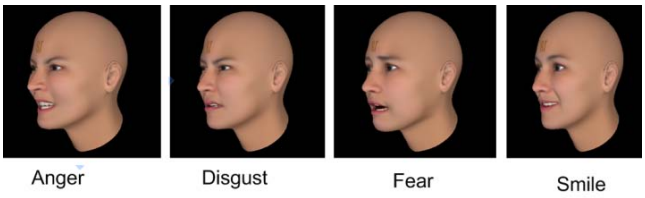

Figure 3-The figure shows anger, disgust, fear, and smile expressions. These expressions when used in creating persona may help designers connect with their persona better.

Research suggests that one of the pitfalls in persona creation is the stereotyping or dehumanizing of potential users (Turner and Turner, 2010). It is a common mistake to believe that persona is a scientific tool. Some studies employ data-driven methods in creating the personas and extensively apply statistical methods to analyze the data (McGinn and Kotamraju, 2008). Yet the data-driven method is argued against as not capturing the true nature of persona. Persona is mainly a designer's imaginative tool rather than a scientific tool (De Voil, 2010).

The persona employed in this study captures several critical criteria for designing personas, which include life, work, activity, social-interaction, cognition, and affection of young adults. For developing the persona, information was gathered by exploring literature on dyslexia. After going through extensive literature and reading materials on dyslexia, we developed an understanding of dyslexia and its effects. In addition to literature, we also looked into online videos, personal stories, and interviews, which helped us get a better understanding of the disease. Dyslexia affects each person with a different combination of problems and a varying level of severity, so watching videos and reading personal accounts of people struggling to overcome the disease was important in order to see the variability of the effects of this disease. The team understands that non-valid online materials (such as online videos, personal accounts, etc.) cannot be used for research purposes; however, if carefully chosen, these materials, in addition to research literature, can be of great help. Our data collection in general follows the qualitative and quantitative data collection principles (Elo and Kyngäs, 2008). It is inspired and extended from the open coding method. The data deduction and induction flows were both adapted to the data collection workflow.

The deduction process is to come up with deducted constructs for the persona. The deduction process is to ensure that all data collectors and data coders are equipped with an expert level of knowledge on dyslexia symptoms as well as a patient's general cognition, behavior, family relations, and emotion. All data collectors and data coders are required to read extensive research papers, articles, and case studies about dyslexia diseases before conducting data deduction. Only after being acknowledged as knowledgeable about dyslexia can the data induction process be started. The data induction process is to code the data and formalize the constructs including life, work, activity, social-interaction, cognition, and affection.

In the data coding process, first, the five categories including life, work, social, cognition, and affection were constructed, which is a deduction process. Second, data observers started to collect online videos and descriptive personal stories. Third, the five data categories were rated with a confidence rating; the confidence rating given as high: 5 to low: 1.

To code the data collected from videos, three team members worked as coders independently. After finishing the content coding and giving the confidence rating, three data coders collectively compared the five dyslexia content codes and confidence rates for these five categories. The similar content codes were combined. The different content codes were selected based on coder's discussion. The confidence rating for each category was also carefully discussed. The low confidence rating category was eliminated based on coder's final votes.

The persona development is a mix between a data-driven model, research literature, and imagined character behavior, which attempts to avoid the pitfalls of a solely data driven model and a solely imagined character model (Triantafyllakos et al., 2009, De Voil, 2010).

Our design interest is to design a smart phone software application for individuals with dyslexia. As dyslexia affects reading and writing abilities, we decided our target users should be school going teenagers and young adults. Students/young adults suffering from dyslexia, even though they have the caliber to excel, are not able to progress at the same rate as their peers, leading to

frustration and behavioral problems. The main design goal is to help these young adults gain better academic achievements, resulting in higher self-esteem and self-confidence, hence improving their relationship with the people around them and society as a whole.

The persona creation is based on the data we collected. Some main features such as reading, writing difficulties, behavioral impact of being dyslexic, and uneasy relationship with others are from the data we collected. Several features of the persona are developed based on research literature, like the root cause of dyslexia, and the compromised working memory. Some other detailed features, such as college life, are based on our team's perception of life activities during college. Several personas were created and one of the personas created by our team is demonstrated in Figure 4. This sensitive persona proved useful to our team in stimulating design and considering dyslexia problems in terms of cognition, activity, action, work, and social aspects–improving the social reader design quality. We defined one persona as Charles, who is *used through Social Reader wireframe and prototype design and evaluation phases*.

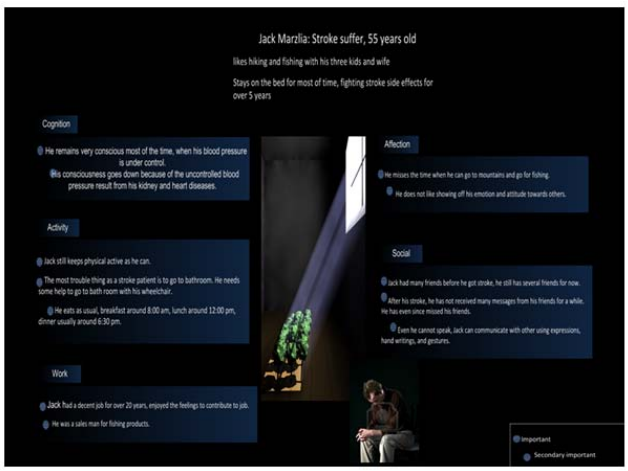

Figure 4-Example of sensitive persona (black color represents Jack suffers from depression and low self-esteem; sun light beside of him represents that he keeps a hope of future life)

PHASE 2: Creation of Work Activity Affinity Diagram

The work activity affinity diagram (WAAD) activity was performed by a three person design team. The main goal of the WAAD was to make a contextual inquiry of the main features of the mobile application. Before WAAD, the team already had rough ideas of the mobile app. Brainstorming was done by every design team member, which yielded a myriad of design ideas. Each team member came up with their own set of ideas for requirements/expectations from the mobile application to aid individuals with dyslexia. These ideas for requirements were put on post-it notes and then stuck onto a whiteboard. After putting the work-activity notes on a whiteboard, everybody examined each other's notes. The work-activity notes that could not be understood were explained by the team member who had come up with that idea. After going through all the work-activity notes, five categories including engagement, encouragement, feedback, connection and assistance were made. Each work activity note was put under one of the categories. WAAD camera shot is shown in Figure 5.

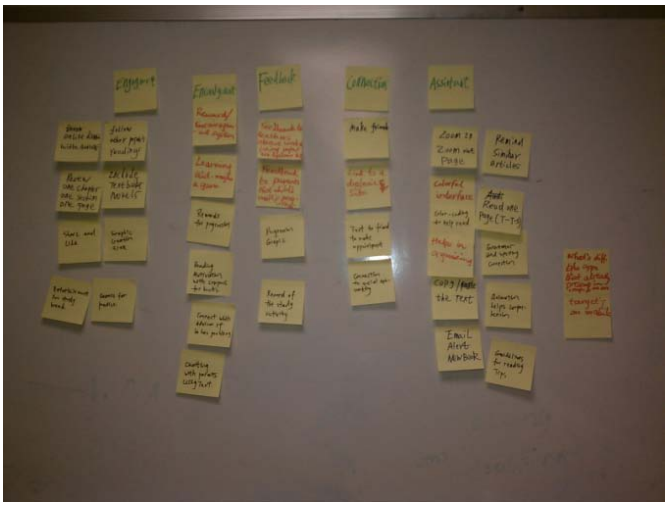

Figure 5-Social Reader work activity affinity diagram (WAAD)

PHASE 3: Social Reader Wireframe Creation and Evaluation

Social Reader Wireframe Creation

The design of the Social Reader wireframe was performed in two phases. The first phase was the sketching-on-paper phase shown in Figure 6 and 7. The second phase was a computer based drawing shown in Figure 9. The main purpose of the first phase was 'ideation,' to come up with different ideas and put them on paper. It was observed by the team that brainstorming

and coming up with ideas was easier by using paper and sketching rather than just coming up with ideas mentally and not recording them on paper. Paper sketching helped provide more clarity to the thought and encouraged coming up with a number of different ideas, which could be used for the synthesis of the wireframe in the second phase. Following the paper-sketching phase, the initial synthesis of the wireframe was done. The second phase used this initial synthesis of the wireframe and it was updated with several iterations.

The paper sketching of the wireframe was performed by each individual team member, as shown in Figure 6. Each of the three team members brainstormed and drew as many wireframes as they wanted to come up with. Then the team members got together to discuss the ideas they had come up with while creating paper sketches. The discussion of the created wireframes helped to make a common ground for the design ideas, such as what the design elements represented and whether the features of the wireframe well-represent the Social Reader requirements (i.e. engagement, encouragement, connections, assistance, and feedback functions). Some of the design ideas were eliminated after discussion, since they did not either represent the Social Reader requirements or fulfill the design meaning sufficiently.

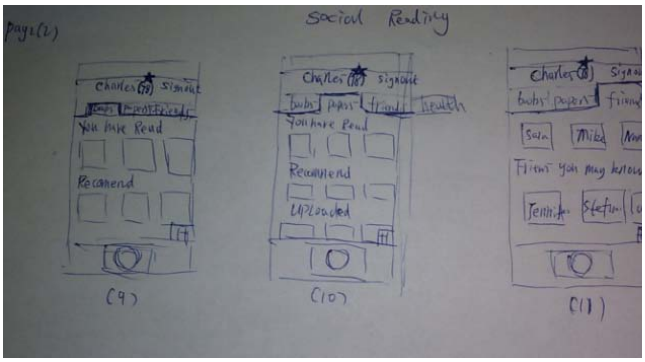

Figure 6-Example of hand drawing wireframe

During the wireframe phase, it was also found that the text description of the wireframes was helpful for the design team members to understand each other's wireframe more efficiently, as shown in Figure 7. The wireframe with text description is very similar to a storyboard, which has been proven useful for communicating designs within a design team (Hart, 1999, Van der Lelie, 2006). As such, in the later phase of the wireframe, text description of the wireframe, also called wireframe-storyboard, was encouraged.

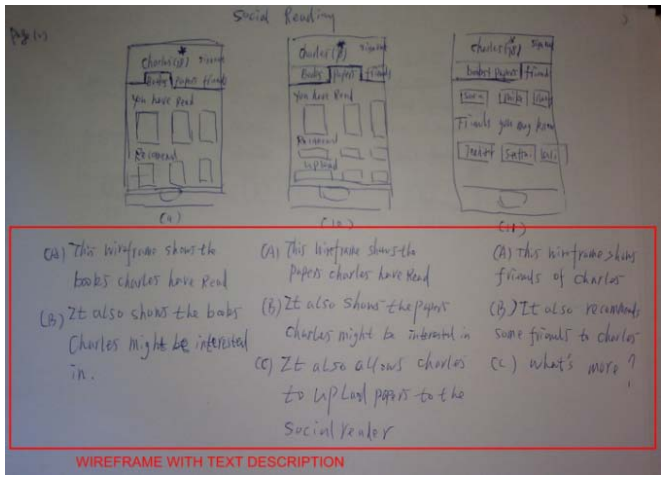

Figure 7-Enhance wireframe with text description for each scene of the wireframe. The enhanced wireframe is also known as wireframe-storyboard.

Following the sketching phase, the design team created a number of wireframes. These wireframes helped the design team to solidify the design of social reader. Once the design team understood the design ideas that would fulfill the design requirements and had a clearer picture for a feasible design, then computer based wire-framing was started.

Social Reader Wireframe Evaluation

In order to achieve immersion of the evaluators into the character of the persona, the personal story of Charles had to be well described on paper and handed over to the evaluators by a design team member working as the administrator and leading the evaluation. The story of Charles needed to be easy to read and followed by evaluators in a piecemeal manner. After reading Charles's story, the evaluators were asked to answer several short questions to ensure the evaluators really understood Charles's experiences, his cognition, and his affection. After that, the evaluators were given the wireframe (as prints on paper) to evaluate. The design team member was responsible for introducing the wireframe to the evaluators. The introduction included the wireframe navigation and the function of each slide of the wireframe. The design team member also helped the evaluators understand the functions of the buttons and the navigation process between corresponding wireframe screens. For example, they explained the meaning of UI elements as well as the meaning of some links between the wireframe screens. Following the introduction of the wireframe, the evaluators wrote their evaluation on a paper sheet provided by the administrator. The persona self-guided evaluation method is shown in Figure 8.

In Figure 8, step 5 is the actual evaluation step. In this step, evaluators were required to comment on the usability of the social reader wireframe. The comments from evaluators include the dyslexia content code, the related wireframe features, the features they liked, the features they disliked, and the solutions to address the

features they didn't like. The dyslexia content code was not pre-specified, since we feel that the pre-determination of the dyslexia content code might force evaluators to make comments based on what they have pre-determined. More discussion of this will be presented in the results section.

From step 2 to step 3, we tried to ensure that there were no disturbances to the evaluators. The aim of this was to ensure that the evaluators could immerse themselves in the Charles story. However, if the evaluators really have difficulties in interpreting the Charles's story on their own, assistance will be given to them for a thorough understanding of Charles's story. It also should be noted that in step 6, the interview with the evaluators should be only conducted after the evaluators finish the evaluation writings. Any rush to make an interview will disturb the evaluators as they continue to comment on the usability of the social reader wireframe.

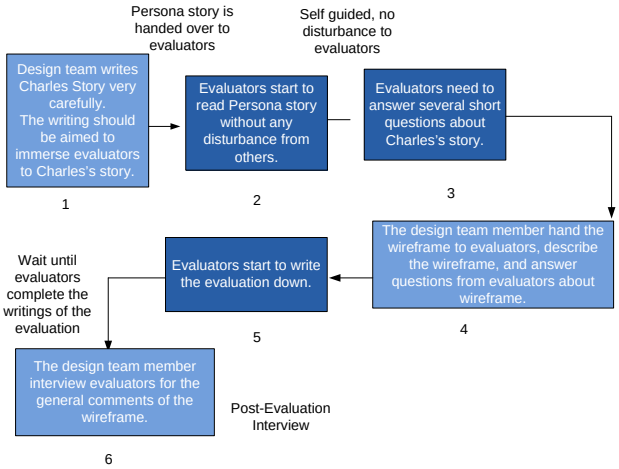

Figure 8-The flow chart of persona self-guided evaluation method

After completing the evaluation session, we can obtain the persona self-guided evaluation matrix, which is shown in Table 1. Each evaluator's evaluation will be formalized into the persona self-guided evaluation matrix.

	Life	Study	Activity	Social	Cognition	Affection
dyslexia content code	N/A	N/A	N/A	N/A	N/A	N/A
Wireframe Features	Profile page Login page	Search functions page	N/A	Chat with Volunteers page	Reading page	N/A
Like	Like the picture on the profile page. Also like the large text	Like the icons used on the search bar	N/A	The keyboard is large enough making it capable of chatting	Like the large font size. Also like the text-to-speech (T-T- S) function	N/A
Dislike	Donations should have its own page. The password, which is difficult to use for Charles.	There are too many texts on the search page	N/A	Lack of voice/sound integration	It should include text annotation functions, which support more powerful color based highlighting.	N/A
Solutions	Build a new page for donations Think about new login technique, which can help Charles easy to login	Increase use of Icons and decrease use of texts	N/A	Possibly create video chat function, reduce use of texts	Include the text highlighting functions	N/A
Overall comments	The low fidelity prototype was effective at getting the idea and direction across. However there are limited functionalities that pertained directly to the cognitive disability. Increase the features that will help him with his cognitive disabilities. This will increase the scope of the program. But I think it will be more complete design with more function that help with dyslexia.					

Table 1-Persona self-guided evaluation matrix

From the results, it seems most of the evaluators do not really perceive the Charles affection very well. Two of the evaluators asked what the meaning of affection is. It is not surprising that evaluators cannot capture Charles's affection in 20 to 30 minutes of reading. More clear description of Charles's affection is needed in order to allow evaluators to have a clearer understanding of Charles's affection.

The evaluators also complained that there were too many self-test short questions, which overwhelmed the evaluators. However, the purpose of these short questions was to help them get more immersed into the Charles story. But too many questions can be annoying and take a long time to complete. It also resulted in less time left for the persona self-guided evaluation.

From the post-evaluation interview, it was also found that most of the evaluators felt that they were immersed into the persona and were able to understand Charles's conditions. One evaluator said:

"*I am quite into the story, I do not have to go back to the slides to look for answers, when I answer the short questions*"

Following the wireframe evaluation, the wireframe was improved, as seen in Figure 9. For example, in evaluation, an evaluator complained that the functions to adjust paragraph highlighting and font size should be more visualized. Figure 10 demonstrates how paragraph highlighting and font size adjust functions in the wireframe were improved.

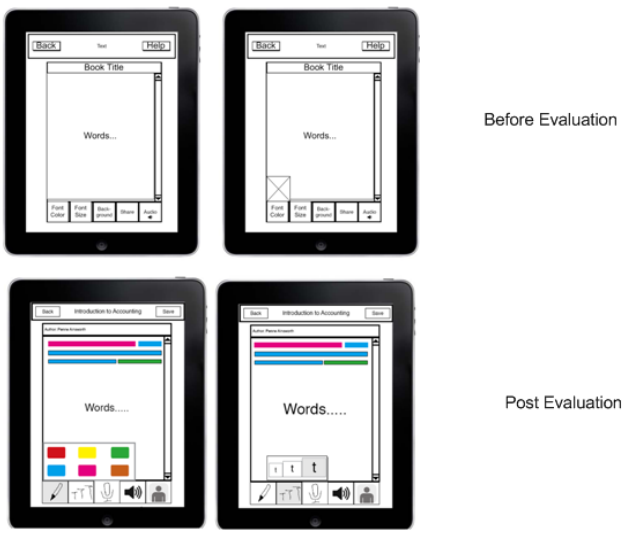

Figure 9-Social Reader wireframe (before evaluation, post evaluation)

PHASE 4: Social Reader Prototype Creation and Evaluation

Social Reader Prototype Creation

From the Social Reader synthesis phase, the Social Rader wireframe was built. The wireframe has the most expected features such as login, profile page management, searching books, book reader, and a link to find volunteers for help. However, these pages are still considered rough, containing some flaws in the designs, functions, and navigations. Our first task is to critique the problems existent in the wireframe pages. Known critique plays a key role in our design.

Proposal-Critique-Modify (PCM) has been commonly used in design. (Propose) It proposes a partial or complete design, (Critique) it identifies the flaws, problems, and causes of the failures, and (Modify) it modifies proposals to satisfy the design goals (Loram et al., 2005). The design critique is a process, which can help to find the causes of failures and improve the design.

The wireframe critique is conducted as shown in Figure 11. Each team member is assigned the task to critique the wireframe from page to page. The team members are required to write down the problems they identified. The problems can be related to UI, functions, or navigation of social reader. The solutions to the problems are also required to be given.

In Figure 10, for the first step, each team member was asked to critique the wireframe. It was found that some team members liked to list every single detail of the critiques as well as the solutions. However, others preferred to give an overall critique for the wireframe page. The inconsistent critique style did not lead to any issues in the group discussion phase, which is the third step, because team members could express the identified problems and feasible solutions verbally without too many difficulties. The examples of critiques and solutions are shown in Figure 11.

In Figure 11, it is found that the claims are used extensively during the wireframe critique process. Especially for solutions of the critiques, team members prefer to use claims, which contain both positive and negative sides of the solutions. The claims also play an important role in communicating the design ideas efficiently.

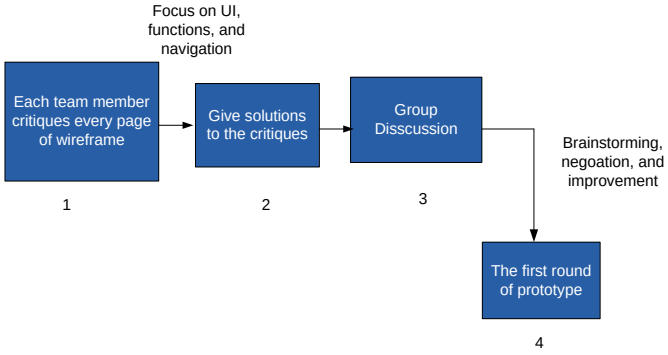

Figure 10-Wireframe critique and first round prototype generation process

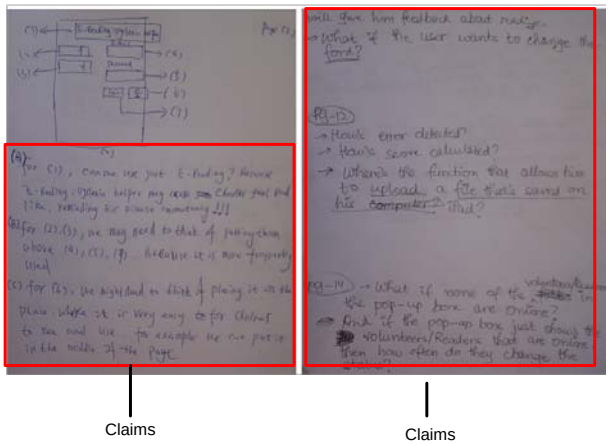

Figure 11-Wireframe critique and first round prototype generation process, using claims extensively during the critique process

Social Reader Prototype Evaluation

Think aloud is used in the social reader prototype evaluation process. Similar to the wireframe phase, it is also not feasible to recruit individuals with dyslexia to evaluate the Social Reader prototype. The non-dyslexia (healthy) adults are available for the Social Reader evaluation. In order to minimize the evaluation errors possibly arising from the gap between the healthy adults and individuals with dyslexia, the persona is introduced to the think-aloud protocol.

Similar to wireframe evaluation, Charles's story is thoroughly introduced to the evaluators. The purpose of doing this is to immerse the evaluators into Charles story and to augment the common ground between Charles and the evaluators. The success of immersing the evaluators into Charles story can help by reducing the participant associated invalidities of the evaluation.

As it is shown in phase one, the persona consists of several following dimensions; life, study, activity, social, cognition, and affection. The think-aloud protocol can reveal numerous evaluators' complaints or comments based on the evaluators' verbal reactions. By knowing the connections between the evaluators' complaints and

persona dimensions, the improvement of the Social Reader prototype can be better directed to match the design goals.

For example, the goal of Social Reader focuses on developing a social infrastructure, which can foster Charles's engagements and reading interactions by adding a social aspect. We aim to realize such design goals by stimulating the social reader user's cognitive elements such as memory, attention, action, perception, and problem solving. This method is based on the hypothesis that the cognition performance is positively correlated to the reading, writing, and organization performance of individuals with dyslexia (Burden, 2008, Bull, 2009, Terras et al., 2009).

As such, the think-aloud protocol analysis is strongly associated with persona cognition such as memory, attention, action, perception, and problem solving. By clearly labeling the think-aloud verbal analysis results with cognitive elements, we can have the prototype developed towards solving the dyslexia cognition problems.

Since persona think-aloud protocol is still explorative, the validity of the results can be better ensured by verifying the think-aloud verbal coding results (conducted concurrently) with the post-task user's comments on the task features, which are performed retrospectively. If there is a high consistency between the think-aloud verbal coding and the post-task user's comments on the task features, the validity of the persona think-aloud can be protected.

The persona think-aloud protocol is demonstrated in Figure 12. As shown in Figure 12, special consideration should be made for ensuring that no disturbance is made to the evaluators during the persona reading, self-reflection process, and the think-aloud process.

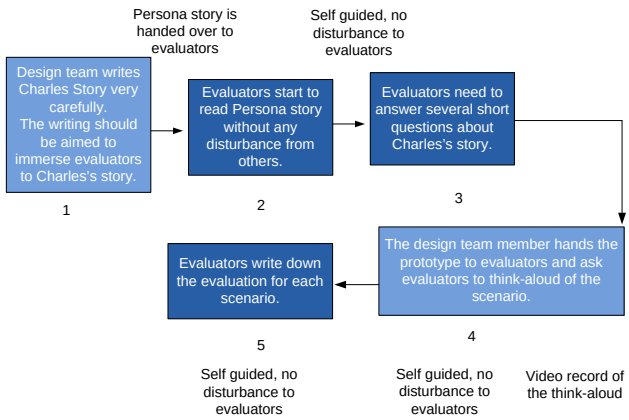

Figure 12- Persona think-aloud protocol

The persona think-aloud protocol can form the following persona think-aloud evaluation matrix shown in Table 2. In Table 2, three scenarios are used for the think-aloud protocol. The first row includes the persona dimensions. The second row is the think-aloud verbal coding results, which are the phrases and statements abstracted by coders from the broken down verbal protocol data.

The third row of Table 2 is the user comments, which are the favorite features of the social reader the evaluator encountered in a scenario. The fourth row is the least favorite features of the Social Reader the evaluator encountered in a scenario. The three scenarios used in the persona think-aloud evaluation are shown in Figure 13. These scenarios cover major functions of the Social Reader and can be used to test most of the functions of the Social Reader. Two evaluators completed the evaluation and yielded two persona think aloud evaluation matrices. The matrices are shown in Tables 2 and 3.

First Participant	First Scenario	Second Scenario	Third Scenario
Persona Dimensions	Study, Cognition	Study, Cognition	Study, Social, Activity, Cognition
Think Aloud	(1) Expect some help features before login, such as forgot password **(Problem Solving)** (2) Feel confusing for what the donation means **(Perception)** (3) Not sure where to hit after search **(Action)** (4) Feel confusing for the search categories **(Decision making)** (5) Want undo features when highlighting text **(Action)** (6) Feel confusing for the speaking and text to speech features **(Decision Making)**	(1) Want to adjust the volume of the speaker **(Action)** (2) Expect two different voices (Male/Female) **(Perception)** (3) It is not sure why need to record the reading using Microphone **(Decision Making)**	(1) Expect help functions **(Problem Solving)** (2) Like the video chat function **(Decision Making)** (3) Expect the video chat function be adjustable **(Perception)**
User Comments (Like)	Font Size	Read aloud of the text	(1) Video Chat (2) Social Network function
User Comments (dislike)	(1) No undo features (2) No help for forgot password features (3) Feel confusing for the honor feature on the profile page	(1) Can undo the recording, track how much has been recorded (2) Expect male and female voices (3) Can adjust reading speed	(1) Need more help features (2) Expect the video window to be adjustable

Table 2-The Social Reader persona think-aloud evaluation matrix

Second Participant	First Scenario	Second Scenario	Third Scenario
Persona Dimensions	Study, Cognition	Study, Cognition	Study, Social, Activity, Cognition
Think Aloud	(1) Guess the first page is loading, but not really sure **(Perception)** (2) Feel confusing for what the searching category means **(Problem Solving)** (3) The search function is too limited **(Perception)** (4) Cannot find the keyboard to enter user name (Action) (5) Not sure how to highlight **(Action)**	(1) Feels the task is very easy to follow **(Perception)**	(1) Prefer to use the video chat function **(Decision Making)**
User Comments (Like)	Like the font size, color, and functions	Feel very easy to use	(1) Video chat (2) Text chat
User Comments (dislike)	(1) The search functions are too limited	(1) Is it possible to select specific text to increase its size?	(1) Need some to the reader icons, for example the text to speech icon

Table 3-Social Reader persona think-aloud evaluation matrix

First Scenario

Please login, go to profile page and search for book titled accounting. You also need to read the book, highlight it with different colors and also try to read the book using different font size.

Second Scenario

Please read introduction to accounting book using the E-reading. You are expected to read aloud the text of the book for 1 min with the audio function of E-reading. Then, you also need to use the text-to-speech function, which can help you to read the book.

Third Scenario

Now you have some trouble for reading the introduction to accounting book. First, you need to find some volunteers or other readers to help you out. Then, you will also make text or video chat with them to get the help for reading the book, such as assisting you for understanding one equation and two sentences you feel confused on the page 495.

Figure 13-Persona think-aloud evaluation scenarios

Following the evaluation, evaluators were asked whether they felt comfortable using this new evaluation method. Both evaluators said they felt that it was quite easy to follow the evaluation process. They can remember the story of Charles (the persona) very well during the whole evaluation process. After evaluation, the Social Reader final prototype was made and improved as seen in Figure 14. It demonstrates the paragraph highlight and font size adjustments, includes a video chat, and has a search for other readers function.

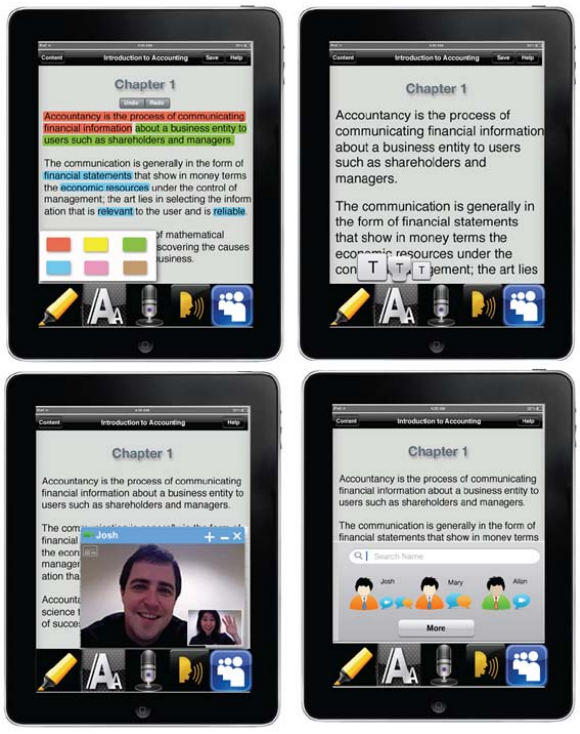

Figure 14-Social Reader final prototype

Conclusions

This paper described a usability engineering approach to create a tool that will help people with dyslexia. In particular, the use of a persona seems particularly important for people with cognitive disabilities, as personas have the ability to specify features of a person (and thus features of a disability) and thereby elicit the proper care and understanding from the designers. Our research traces the use of a persona continuously throughout all different phases.

The first and second phases are contextual inquiry and analysis and persona creation. In the first phase, we created a sensitive persona, emphasizing the empathy of a persona and stimulating designers to achieve outstanding designs for individuals with dyslexia. In the third phase, the persona self-guided evaluation method is used to maximize validity in expert review when a full usability evaluation with people with dyslexia cannot be performed. It immerses evaluators unfamiliar with dyslexia in a "Charles's persona to achieve similar results. Another potential advantage of using the persona self-guided evaluation method is that this method can help achieve a more user centered evaluation. Often, user centered design focuses more on using persona in early design and less on using persona for evaluation. However, when the product is in evaluation, it is not really evaluated by persona, but by general users. This gap is filled by the persona self-guided evaluation method. Note that this type of expert evaluation cannot fully replace user testing, but enables designers to create a better product when the target user population is not accessible.

In the fourth phase, we used a novel persona think-aloud method. It is developed with similar motivations as the persona self-guided evaluation method. The difference is that the persona think-aloud evaluation method combines personas with the think-aloud method, the latter of which is used extensively in HCI communities. Think-aloud typically involves end-users for evaluation. As such, persona and think-aloud shows harmony by enhancing the fidelity of user-centered design and evaluation, where the product is often designed for a specific group(s) but not evaluated by a specific group(s). We feel the evaluation methods have shown promise, though having even more guidance for evaluators would reduce evaluator complaints and improve the quality of the feedback.

REFERENCES

1. Blau,V., van Atteveldt, N., Ekkebus, M., Goebel, R., Blomert, L. (2009). Reduced neural integration of letters and speech sounds links phonological and reading deficits in adult dyslexia. Current Biology, 19, pp. 503-508.
2. Blomquist, Å., Arvola, M. (2002). Personas in action: Ethnography in an interaction design team, pp. 197-200.

3. Brandt, E. (2006). Designing exploratory design games: a framework for participation in Participatory Design?. ACM, pp. 57-66.
4. Bull, L. (2009). Survey of complementary and alternative therapies used by children with specific learning difficulties (dyslexia). International Journal of Language & Communication Disorders, 44, pp. 224-235.
5. Burden, R. (2008). Is dyslexia necessarily associated with negative feelings of self worth?. A review and implications for future research. Dyslexia, 14, pp. 188-196.
6. Carter, M., Rastatter, M.P., Walker, M.M., O'Brien, K. (2009). The effects of frequency altered feedback on the reading processes of adults with reading disorders. Neuroscience letters, 461, pp. 69-73.
7. Cooper, A. (2004). The inmates are running the asylum: SAMS publishing.
8. De Voil, N. (2010) Personas Considered Harmful.
9. Elo, S., Kyngäs, H. (2008). The qualitative content analysis process. Journal of advanced nursing, 62, pp. 107-115.
10. Genesee, F., Paradis, J., Crago, M.B. (2004). Dual Language Development and Disorders: A Handbook on Bilingualism and Second Language Learning: Brookes Publishing Company.
11. Hart, J. (1999) The art of the storyboard: storyboarding for film, TV, and animation: Focal Pr.
12. Jiao, J.R., Zhang, Y., Helander, M. (2006) A Kansei mining system for affective design. Expert Systems with Applications, 30, pp. 658-673.
13. Joly-Pottuz, B., Mercier, M., Leynaud, A., Habib, M. (2008). Combined auditory and articulatory training improves phonological deficit in children with dyslexia. Neuropsychological rehabilitation, 18, pp. 402-429.
14. Khalid, H.M. (2006). Embracing diversity in user needs for affective design. Applied Ergonomics, 37, pp. 409-418.
15. McGinn, J.J., Kotamraju, N. (2008). Data-driven persona development. ACM, pp. 1521-1524.
16. Nielsen, L. (2004). Engaging personas and narrative scenarios. A study how a user-centered approach influenced the perception of the design process in the e-business group at AstraZeneca Copenhagen Business School Editor, Fredriksberg, Denmark.
17. Nieters, J.E., Ivaturi, S., Ahmed, I. (2007). Making personas memorable. ACM, pp. 1817-1824.
18. Nunes, F., Silva, P.A., Abrantes, F. (2010). Human-computer interaction and the older adult: an example using user research and personas. ACM. pp. 1-8.
19. Pruitt, J., Grudin, J. (2003). Personas: practice and theory. ACM, pp. 1-15.
20. Ronkko, K. (2005). An empirical study demonstrating how different design constraints, project organization and contexts limited the utility of personas. IEEE, p. 220a.
21. Swindells, C., MacLean, K.E., Booth, K.S., Meitner, M.J. (2007). Exploring affective design for physical controls. ACM. pp. 933-942.
22. Terras, M.M., Thompson, L.C., Minnis, H. (2009). Dyslexia and psycho social functioning: an exploratory study of the role of self esteem and understanding. Dyslexia. 15, 304-327.
23. Torgesen, J.K., Wagner, R.K., Rashotte, C.A, Herron, J., Lindamood, P. (2010). Computer-assisted instruction to prevent early reading difficulties in students at risk for dyslexia: Outcomes from two instructional approaches. Annals of Dyslexia, pp. 1-17.
24. Triantafyllakos, G., Palaigeorgiou, G., Tsoukalas, I.A. (2009). Design alter egos: constructing and employing fictional characters in collaborative design sessions. British Computer Society, pp. 20-28.
25. Turner, P., Turner, S. (2010). Is stereotyping inevitable when designing with personas?. Design Studies.
26. Van der, Lelie, C. (2006). The value of storyboards in the product design process. Personal and ubiquitous computing, 10, pp. 159-162.