CHAPTER 12

CONCLUSIONS AND FUTURE WORK

Lalo: You’ve been reading ‘Belondweg’ this summer—
Amy: I DIDN’T EVEN FINISH IT!
Lalo: That’s OK. I’m talking about the beginning. What happens at the very beginning of ‘Belondweg?’
Amy: The Mordondey kill her da and burn. . . .
Lalo: Not quite. That happens before the beginning. When we first see Belondweg, father’s dead. Her city’s burning. She’s out on the plain crying. . . . Now say you were Belondweg at that moment. Right then. If somebody asked you, would you say you were at the beginning or the end of a story?
Amy: It. . . it would feel like the end of everything.
Lalo: Exactly, but for us, reading the book, it’s different. We know it’s the start of the book. . . . We can feel from the weight of the book that there’s a lot of story left to come.


This dissertation presented an overview of the many sociocultural, economic, political, technical, and environmental factors that influence the adoption and usage of assistive technologies by adults with reading disabilities. The inherent broadness of this topic was approached through the application of Value Sensitive Design. By using this methodology’s principled emphasis on human values and recognition of different stakeholder groups, several multidisciplinary investigations were completed that provided detailed insights as to why certain reading technologies tend to be rejected or abandoned. These investigations also led to the development of new approaches for designing reading-support tools that better address the identified barriers to adoption, diffusion, and long-term usage.

This chapter concludes the dissertation. A summary of the contributions is presented. These include the research findings from the individual chapters and investigations as well as wider contributions that transfer beyond the dissertation’s focus on reading disabilities and related ATs. Directions for future work are then discussed for refining the VSD analysis and for applying and implementing the identified insights. The chapter and dissertation then ends with some final reflections.
Table 12.1: Replication of Table 1.1: Summary of research contributions from this dissertation.

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1 Summary of Findings and Contributions

This dissertation was about understanding the many factors influencing the adoption of assistive technologies by adults with reading disabilities. In order to identify and characterize these influences and propose solutions, an extensive research effort was conducted. The list of contributions reported in Chapter 1 (reproduced in Table 12.1) provides an overview of the primary studies and development that was conducted. In this section, these as well as other research activities conducted as part of their contributions are recounted.

1.1 Synthesis of Research Disciplines

One of the challenges involved in this dissertation was due to its multidisciplinary nature and breadth. Detailed reviews of the literature from multiple fields had to be conducted and presented. This included the need to describe the diverse nature of reading disabilities in both its symptoms and implications on the lives of people.
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with RDs. To do this, Chapter 2 pulled together literature from reading science, cognitive psychology, and disability studies.

Studies and findings from educational technology and computer science research were then compiled to summarize the various assistive technologies that have been made available for people with RDs (Chapter 3). A lack of AT options was noted and demonstrated from both a commercial and research perspective. An analysis of the technologies recommended by leading RD/LD advocacy websites showed that only a narrow range of ATs for RDs are available in today’s market. A literature review of computer science efforts to develop ATs for people with RDs further suggested that research into developing new or improving existing technologies is limited. Reasons for this lack were then proposed and discussed.

The literature on reading disabilities and relevant assistive technologies only provided two-thirds of the necessary background for this dissertation. To understand why or why not different technologies are adopted and used, various theories and studies on technology adoption were brought in (Chapter 4). Drawing from communication research, Rogers’s model of the diffusion of innovations was described. Specific models for the adoption of assistive technologies as well as studies of AT adoption were presented. In particular, research on the adoption of ATs by people with RDs only focused on a narrow range of ATs (Figure 12.1(a)).

1.2 Reading Disabilities, Assistive Technology Adoption, and Value Sensitive Design

From these three literature overviews were distilled the two key research questions for this dissertation: What factors influence the adoption of ATs by adults with RDs? and How can one support and promote the adoption of said technologies? Value Sensitive Design was selected as the overarching framework to address these questions. As a methodology for explicitly accounting for human values in the design and study of technologies, VSD had been utilized for a range of technologies and topics but had not yet been applied to assistive technologies nor AT adoption. This dissertation marks the first such application. The utility of VSD for such work was demonstrated both abstractly and concretely. Aspects of VSD were highlighted as relevant and salient to the issues surrounding AT adoption (Chapter 5), and the ensuing VSD investigations demonstrated how such a VSD study can be conducted. Thus, this dissertation establishes VSD as a valuable and effective research approach for studying AT adoption.

A total of six VSD investigations were conducted for and described in this dissertation. A conceptual investigation started the VSD process by identifying relevant stakeholders and values (Chapter 6). To provide insights and structure for understanding the array of literature consulted for this investigation, a theme-value coding was developed and applied. Various interactions and tensions were then identified among the recognized values with issues of normalcy, privacy, and identity playing dominant, central roles.

Two empirical investigations were then conducted to challenge, validate, and refine this value-stakeholder framework. The first was an observational study of online discussions involving RDs (Chapter 7). Analysis
of the three selected threads provided insights about the opinions and views of multiple stakeholder groups on various issues related to RDs, technology, and society. The second empirical investigation was an interview study of ten reading-disabled adults about the impact of their disabilities on their education, relationships, and other aspects of their lives (Chapter 8). Inquiries were also made about their literacy practices and technology usage. Both investigations reified aspects of the value-stakeholder framework and provided insights into the desire to hide and pass as normal.

The value-stakeholder framework and the findings of the previous investigations were then applied in three technical investigations. Existing reading technologies were evaluated in terms of how well they promoted or worked against various values (Chapter 9). General design guidelines and recommendations for building better ATs for adults with RDs were then derived from the insights of the value-stakeholder framework (Chapter 10). The final technical investigation (Chapter 11) utilized these design guidelines as the basis for the Calico reading system. Through its use of an extensible framework and support through the original notion of meta-tools, Calico promotes self-advocacy as well as flexible features to manage and control disability visibility across multiple contexts.

These VSD investigations fill in a gap in the research earlier noted in a review of AT adoption studies (Section 3 in Chapter 4). As shown in Figure 12.1, this dissertation focused exclusively on reading disabilities and considered multiple types of assistive reading technologies. This combination was not previously seen in

![Figure 12.1: Distributions of previous and this dissertation’s research studies on AT adoption. Numbers correspond to the studies listed in Table 4.2. A greyed circle indicates the study involved participants with LDs or RDs. (a) Plot showing focus on reading disabilities versus number of ATs in the study. (b) Previous plot with the dissertation studies shown.](image-url)
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the AT adoption literature. By addressing this gap, the process of AT adoption was found to be reflective of the decision process to hide or disclose one’s disability. Due to the values our society places on literacy and normalcy, many people with RDs feel compelled to hide their disabilities from others. In keeping the disability private, this includes not disclosing to others about the disability but also influences the choice of what ATs, if any, are adopted into regular use. Technologies that signal to others that the user has an RD may not be used in public situations. To thus manage this appearance of normalcy and avoid stigma risks, technologies need to provide multiple options in order to allow the user to continually choose the most appropriate technology for the pertinent contexts. Unfortunately, the current diversity of available AT options is insufficient to permit such choices and actions. Technologies must be developed that acknowledge and support these value issues of normalcy, privacy, identity, and choice in order to promote successful technology diffusion.

1.3 General Insights about Assistive Technology Design and Adoption

The contributions and findings from this dissertation are not specific to reading disabilities and assistive reading technologies. Several of the findings generalize to broader issues concerning disabilities and assistive technologies. As previously mentioned, Value Sensitive Design has been demonstrated as an effective methodology for studying the social aspects of assistive technology usage. VSD could be readily applied to other disability types in order to discover the aspects and nuances that influence AT adoption and usage. Semiotic engineering was also identified as a means of designing AT interfaces that better communicates to the user the purpose of a technology, how to use it, and how to configure it (Section 3.3.1 in Chapter 11 and Deibel (2007a)). The PATTC framework (Person, (dis)Ability, Task, Technology, and Context) was derived from previous AT adoption studies and existing AT adoption models to scaffold understanding of the various facets influencing AT adoption and usage (Section 4 in Chapter 4). Though derived with ATs and disabled users in mind, the PATTC framework is applicable to all ranges of use abilities, technologies, and tasks.

Specific elements of the value-stakeholder framework are also applicable beyond the reading disability scope of the dissertation. The importance of the value of normalcy and role of indirect stakeholders who stigmatize people of disabilities in influencing technology adoption apply to other disability types. People with other types of disabilities will also sometimes opt to hide their disabilities from others if possible (Kuusisto, 1998; Cory, 2005; N. Matthews, 2009). Issues of normalcy and stigma have also been identified with other disability types, such as deafness (L. J. Davis, 1995; Lane, 1997), conditions requiring the use of a wheelchair (Scherer, 2005), and psychological conditions (Cory, 2005; Brown, 2009; L. J. Davis, 2009). People who demonstrate difficulties with reading but not necessarily due to an RD also experience stigmas related with normalcy and literacy. For example, the remedial reading students in Gomez et al. (2004) engaged in deliberate tactics to resist being labeled as such by their teacher and school. The findings and methodologies in this dissertation can apply to these various groups for understanding their reactions to technologies, educational
policies, and other value-influenced aspects of our society.

1.4 Refinement of Value Sensitive Design Methodologies

As an exercise in Value Sensitive Design, this research also contributed to VSD methodology in several ways. On a high level, the topics to which VSD can be applied was expanded to include disabilities and assistive technologies. As a result, the values of normalcy and literacy were added to the larger list of values that have been explored in early VSD studies. Insights were also made about VSD’s relevance and compatibility with models of technology adoption (Roger’s diffusion of innovations and my PATTC framework) and the medical and social models used in disability studies (Section 4 in Chapter 5).

Methodologies used within VSD were also refined and improved. Although the literature review is not a new technique, the dual-coding and the density mapping used in the theme-value analysis in the conceptual investigation in Chapter 6 provides a new means of managing and understanding the role of different values in literature that spans multiple disciplines. Another improvement on a VSD technique involved the value flows and dams introduced by Miller et al. (2007). The concept was expanded such that dams and flows could be identified in more than just empirical investigations. An example was given of identifying dams and flows during a conceptual investigation (Section 4.3 in Chapter 6).

Most notable among the refinements to VSD was the introduction of a new type of indirect stakeholder—those who affect technology usage (Section 1 in Chapter 6). Originally, the VSD methodology concerned supporting values of those who use a technology as well as those who are affected by such usage. Because society influences the usage of and values associated with a technology, some members of society influence the usage and impact of that technology due to actions and decisions informed by their value system(s). In recognizing the various stakeholders and their values that promote or dissuade technology adoption, designers using VSD can thus make more nuanced decisions about which values should or should not be supported in designing a technology or policies regarding its use.

2 Future Work

The above contributions and findings do not mark the end of the research presented in this dissertation, however. The work is ongoing, and several directions are planned for the future. These include continuing some of the VSD investigations already conducted as well as new studies to address gaps in the current understanding and research coverage.

2.1 Continuing the Theme-Value Literature Review

New work and insights are continually taking place in the various, multiple disciplines involved in this dissertation. When new publications relevant to this dissertation are found and read, they can be coded and
integrated into the theme-value mapping. Although the papers included in this review are not meant to be a statistical sampling of all of the relevant research, the addition of more papers does help to strengthen and better define any of the patterns that informed the initial value identification. The use of the theme-value coding framework also supports my ongoing understanding of the many nuances and issues involved in the broad scope that this line of research entails.

2.2 Addressing Missing Values

In continuing the theme-value literature analysis, new themes and values may be identified and folded into the framework. Two such values have already been recognized. As mentioned in Chapter 6, Section 4.4, one audience member inquired about the absence of diversity as a value in the framework. As part of the empirical investigation presented in Chapter 7, analyses of online discussions involving RDs also found mentions of the importance of diversity. Another missing value identified in the two empirical investigations (Chapters 7 and 8) was characterized as awareness of how people differ in their experiences and issues faced in life. Reviews of the literature will be conducted to identify instances of these values within the existing set of 57 papers as well as any new papers brought into the review.

2.3 Conducting and Continuing Additional Empirical Investigations

The importance of diversity and awareness as well as the other elements of the value-stakeholder framework will be validated and further explored through future empirical investigations. One direction will be to continue the empirical investigations presented in Chapters 7 and 8. More online forms and discussion threads will be selected for analysis. The life stories of the interviewed participants will be composed, and additional insights will likely be noticed during that process. Additional interviews may also be conducted by recruiting more adults with RDs.

2.3.1 Additional Interviews of Individuals with Reading Disabilities

In particular, certain subsets of this direct stakeholder population will receive greater focus. One group of interest will consist of individuals like Harold, Ashley, and Calvin who received their RD/LD diagnosis as adults. As mentioned in Chapter 8, Ashley and Calvin struggled in school and only finally understood the reason for their difficulties later in life. Meanwhile, Harold only began to experience difficulties while in college. The experiences of these three individuals offer a different perspective on living with a disability, what it means to be normal, and how literacy difficulties shapes one’s identity.

Another group of interest will be individuals who have participated in disability advocacy activities like DO-IT (2010) and Project Eye-to-Eye (2010). As mentioned in Chapter 11, Section 2.1, these groups are part of a larger social movement to change social aspects of disability. DO-IT provides information and social networks to promote the use of ATs, enrollment in higher education, and employment for all people with
disabilities. Project Eye-to-Eye establishes mentoring efforts between children and adults with RDs/LDs in order to challenge conventional views of what is normal. Adults who participated in these programs will likely have different reactions to issues related to social stigma and the value of normalcy. These differences may also be reflected in their usage of reading support technologies in that concerns about being labeled by their usage would be lessened. Thus, this subgroup would offer an interesting and different perspective from the participants already interviewed.

2.3.2 Interviews with Indirect Stakeholder Groups

One weakness of the research presented in this dissertation has been the heavy emphasis on the direct stakeholder group of adults with RDs. Considering the viewpoints of other stakeholder groups is already a key concept within Value Sensitive Design, but the importance of this was demonstrated especially in recognizing the omission of the values of diversity and awareness. The audience member who queried during the defense about the whereabouts of diversity in the framework is a disability advocate and AT developer. Of the three online discussion threads analyzed in Chapter 7, awareness and diversity were the most prevalent in the thread involving college writing instructors discussion disability (Section 2.2). These two examples primarily involve indirect stakeholder groups, thus demonstrating the need to bring in more of their insights.

Several directions will be used to explore the viewpoints of various indirect stakeholder groups. One approach will be to find more papers that express the concerns and views of other indirect stakeholders. Examples that are already in the theme-value literature review include studies like Dawe (2006) that emphasizes the opinions of parents and teachers and the study by Kaehne and Beyer (2009) on the role of school counselors in helping students with RDs/LDs transition beyond K-12. More such papers need to be incorporated into the review. This will include articles that express the concerns of instructors and education policy makers questioning the fairness of accommodations such as the already included Zirkel (2000) as well as the more recent reports by Leef (2010) and Vickers (2010).

A new empirical investigation will also be conducted. Using again a semi-structured approach, assistive technology specialists, disability counselors, and special education teachers will be interviewed to gain their insights about various topics. Similar to the review of AT recommendations given by RD/LD advocacy websites (Section 2.1 in Chapter 3), these individuals will be asked to discuss what technologies they suggest and recommend for supporting people with RDs/LDs. The participants will also be asked to describe the factors they believe influence AT adoption. Their reactions to the value framework will also be a critical focus of the interviews, and participants will be expressly asked to indicate gaps and problems with it.

2.4 Implementing and Evaluating Calico

The final direction for planned future work is to continue with the development of the Calico reading system. This will entail both software development as well as user evaluations of Calico’s features and approach to
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delivering accommodations. Development of the Calico’s primarily infrastructure of a document viewer and extensible framework. Doing so will require making software engineering decisions to address the open design questions about the internal document model and computer security as described in Section 4.3 in Chapter 11. Individual reading tools and meta-tools will also be developed to demonstrate the breadth of reading help that Calico can provide.

User evaluation will occur alongside development through an incremental process using medium-fidelity prototypes. A medium-fidelity prototype is a realization of a proposed system that demonstrates its intended functionality but does not fully implement all of the intended features. Essentially a proof-of-concept, this prototyping approach allows the designer to get user feedback without fully implementing or over specifying a system (Lin, Newman, Hong, & Landay, 2000). For instance, a prototype of the Calico system may only ever load and display the same document but still fully demonstrate multiple reading tools being used in parallel. Similarly, a demonstration of the Johnny meta-tool would perform only a simplified RD assessment making answers to the map directly to directly to a limited set of reading tools. For example, if the user highly agrees to the statement “Words become blurry and move if I read for longer than 10 minutes at a time,” then the prototype Johnny would highly recommend a color overlay tool.

Usability evaluations will be conducted with various stakeholder groups. With adults with RDs, the evaluations will explore usability issues of Calico and the effectiveness of different reading tools. Inquiries will also be made about what contexts the user would freely consider using Calico with particular tools activated. Other evaluation studies will involve AT specialists and disability service personnel to gain their insights about how to provide better support with Calico, including identifying ways to better integrate with accommodation policies and how to improve the process by which Johnny assesses a user’s reading performance. To ensure that Calico’s extensibility framework readily allows third-party development of new reading tools and meta-tools, studies involving AT developers will also be conducted.

3 Concluding Thoughts

Although the research work is ongoing, this dissertation has reached its conclusion. Thousands of pages have been read and distilled into 12 chapters encompassing 232 pages of their own. From beginning to end, this work has been about one thing—literacy. Literacy pervades our modern information society, but a significant portion of the population experience difficulty with reading and writing due to being born with a reading or learning disability. Recognizing a fundamental right for all members of society to have an opportunity to succeed in life, society strives to provide accommodations to people with disabilities, sometimes through assistive technologies. This was my original motivation to study reading disabilities and computer technologies, for I wanted to ensure that everyone has the chance to share in my own passion for reading.
I eventually came to realize that providing assistive technologies for reading was not sufficient for achieving this goal. For any accommodation to actually help someone, that person must adopt and use it. This dissertation has shown that despite the existence of assistive reading technologies, adults with RDs tend not to use them despite having the interest and desire to engage in reading. Reasons for this non-use were explored, and it was found that society’s own embracing of literacy discourages those who struggle from reading to demonstrate said struggles publicly.

Essentially, the same literacy that enabled me to complete this dissertation is the same literacy that makes difficulties with reading a disability and stigma in our society. In looking back at the quote that began Chapter 1, Socrates was correct in that the invention of reading and writing would have consequences. He was wrong about the nature of those consequences. Despite his concerns, literacy has allowed us to accrue great knowledge about ourselves and our universe. Unfortunately, literacy has also created a false truth by which we judge members of our society on their abilities relative to the ill-defined notion of normalcy. To make sure that we benefit from literacy, we must understand and address the problems it helps create. This dissertation is one such step toward that goal.