Enabling Increased Financial Literacy for People with Visual Impairments

The objectives of this study are to identify any barriers that people who are blind face when accessing financial information to make an informed and confident financial investment decision

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In our exploratory research study, we aimed to identify barriers that individuals who are blind face with accessing and managing financial investment data. We interviewed five blind individuals to learn their struggles and apprehension with the current investing and banking landscape. We focused on understanding how people accessed information and the tools used during an investment process. We organized our findings into eight themes: graphs, page structural elements, efficiency, resource finding, investment fees, emotions, security, and understanding financial concepts. Based on our findings, we propose recommendations to improve the usability of the investment landscape for financial institutions, including proper labeling on all structural elements such as headers, navigation, buttons, and leveraging narrative summaries into tables and interactive charts and graphs.

CCS CONCEPTS • Human-Computer Interaction • Financial Literacy • People who are Blind

Additional Keywords and Phrases: Accessibility, Blind, Data Visualization, Financial Investing, Financial Literacy, People who are Blind, Stocks, User Interviews, User Interaction

1 INTRODUCTION

According to the 2018 National Health Interview Survey, 32.2 million American Adults aged 18 and older reported experiencing vision loss [11]. Blind individuals have an unemployment rate exceeding 70 percent [3]. Financial literacy provides confidence to make informed financial decisions such as managing life savings, debt, investments, and retirement. The National Financial Capability Study (NFCS) in 2018 conducted a state-by-state online survey of 27,091 American adults and an investor survey of 2,003 Americans and their findings found that 58% of their participants did not receive financial education and only 54% of them had more than 10 hours of financial education [8]. Goodman et al. found that people with disabilities (PWD) have more difficulty covering expenses and paying bills [13], raising the question of whether people with low vision or blindness have equal access to financial information as non-disabled people. According to Jappelli et al., there is a positive correlation between financial literacy and wealth [15]. In the paper, Jappelli cites studies conducted in this space that show that poor financial literacy is associated with poor-risk diversification, inefficient portfolio allocations, and low wealth accumulation [15]. Using data from the 2015 National Financial Capability Study (NFCS), Xiao et al. discovered that adults with different disabilities exhibit different chances of holding risky assets [8]. The article by Van Rooji et al. reveals that financial sophistication is associated with higher wealth, a higher probability of investing in the stock market, and a higher propensity to plan for retirement [12].

Jappelli suggests that raising the motivation to invest in financial literacy education might also lead to higher financial literacy and saving [15]. When adults with disabilities receive help in financial planning, their financial capability, and financial well-being are improved [8]. An additional roadblock to acquiring financial acumen is the challenge of accessing various financial tools such as stock market charts and other data visualizations [2]. Data visualizations convey financial information through bar charts, line graphs, and pie charts [2]. Screen-reader users sought a "holistic overview" of the content within the visualization before deciding whether to seek more in-depth information and compare individual data points. These users suggested that data could quickly identify accessibility through tables with text, trends and employing a multi-modal approach [4]. Specifically, interactive stock market charts are one method that current and potential investors utilize to understand key performance indicators about a stock [6]. For example, the ChartMaster system improves the ability for users to interact with stock market charts by filtering under five main categories of their choosing. The tool then returns a text summary highlighting the requested information, which assists the users in understanding the stock market, thereby increasing their confidence level with investing [6]. Another tool developed by researchers called "Sonify" was also expressly designed to enable increased understanding of financial markets through the "sonification" of line chart visualizations [1].

Lastly, our pre-design exploratory research study aims to uncover blind individuals' issues regarding their financial investments and wealth-building practices. We are looking to learn what challenges blind individuals face when accessing and understanding investment data and information. This study aims to identify any barriers that people who are blind face when accessing financial information to make an informed and confident financial investment decision. Our goal is to provide a list of recommendations that would have implications for design. This list includes a checklist for building financial-related content accessible to all or suggestions for incorporating other technologies such as voice user interfaces (VUI).

2 METHODS

In the following sections, we describe our participants, procedures, data collection, and data analysis methods.

2.1 Participants

We recruited five participants (median age = 38) for the study through a DePaul University network with our professor, Cynthia Putnam Ph.D. All participants were blind and had access to a screen-reader and the internet on a desktop or laptop computer. Recruitment screening ensured that the participants were at least 18 years of age.

Table 1: Participant Demographics

Participant	Age	Gender
P1	50	F
P2	32	M
P3	38	M
P4	72	F
P5	38	M

2.2 Procedures

We conducted virtual Zoom interviews using a protocol we developed; each session took about 45 minutes to complete. Our consent was performed using an accessible PDF and online form. We asked participants questions ranging from their use of voice-related devices to assist with banking and other financial needs and their experience investing in financial products (such as mutual funds, stocks, bonds, real estate, and cryptocurrencies). We asked participants to rate their financial acumen regarding investing in the markets on a scale of 1 to 5, with 1 being a novice investor and 5 being a financial expert about investing in the markets (2.6 average ratings).

Our next set of questions tried to ascertain how our participants accessed financial data. To recognize any critical learning from our participant's experiences with finances, we presented a scenario asking them to imagine writing a letter to their younger self highlighting the top three critical resources. Next, in our deep focus questions, we tried to identify the tools used to access financial information. Finally, we asked participants a series of wrap-up questions to help discover any additional barriers they experienced regarding investing.

2.3 Data Analysis

Our team uploaded the Zoom recordings onto a shared online drive. We then used two methods to analyze our data. First, we transcribed our recording, following which we coded all our interviews using Atlas.ti, qualitative data analysis, and research software. We then took our codes and supporting quotations and added them to a Figma file, an online brainstorming tool to create an affinity diagram. Our team then aggregated our data to identify common themes based on usability and accessibility limitations.

Lastly, we created a list of recommendations and guidelines based on our findings to devise a list of implications for design.

3 FINDINGS

Participants reported accessing and interpreting financial content to make informed and confident investment decisions. One challenge cited was the need to devise “workarounds” and “work much harder” to patch together data from multiple sources to “fill in the gaps” of what is missing. Other challenges included needing to hire financial advisors, accountants, or enlist the help of sighted family and friends to help make sense of:

1. Inaccessible paper-based documents for loans and statements.
2. Visual-only screen elements such as charts and graphs.

3. Overly complex financial information such as the prospectus, narrative summaries, jargon, and terminology.

Participants also expressed frustration with high bank and investment fees, application updates in which they must re-learn how to navigate and decipher tables, and missing labels that block them from completing transactions. Many participants also expressed an overall lack of trust and security because of the barriers to access.

3.1 Graphs

Visual data is not recognized by screen readers resulting in an incomplete picture that requires more research or memorization by the users. In several websites and mobile apps, charts and graphs are not interactive, and sometimes, they are represented as images. This means that it is difficult for screen readers to decipher them for users. When we asked how graphs are represented participant 3 responded, "I'm not able to see and contextualize whether it was just a really good day or whether it was a bad day, or whether those gains or losses have been consistent over time." He told us that he needs to develop his mental graphs by memorizing the daily information to make investment decisions. In addition, Robinhood's investment app previously had audio graphs (an audible representation of the data) implemented, but it was removed with the latest update. Four out of five interviewees expressed their disappointment at this decision.

3.2 Page Structural Elements

The screen reader inaccurately reads web page structural elements such as tables, buttons, tabs, and forms. Participants struggled with deciphering tables; they found it difficult to make the connection between headers and corresponding data. In some cases, tables were read as one long column making the data difficult to comprehend. Participant 3 expressed that the information he received is not as rich as sighted people and it requires much greater effort to gather information to invest."

Data comparisons were also challenging, participant 1 said "I have to figure out how many headers there are and have to figure out what I'm comparing. So, you know, depending on how complicated they are I lose track of that."

3.3 Efficiency

Five out of five participants stated they need another person whether its family, spouses, or financial advisors to help them interpret stock information, legal, security, and general banking. Participant 1 said that they must put in greater effort to get what they need. Participant 4 stated that when she could not get her bank statements in braille, she would have her husband read them to her, and then she would copy down all the information either in braille or on her computer. Moreover, the reliance on others comes with a price, as financial advisors charge fees, and family members may not possess the financial acumen to adequately assist with translating visual charts and graphs

Additionally, when a website gets updated and the content changes, our participants said they must re-memorize the order of contents to find what they need. Furthermore, Participant 1 mentioned, "Schwab redid the design and the layout of their website. And every time they change it, I have to learn it all over again, because quite often, what we do is navigate a page, and we get familiar with it. So if there's headings, or tables, or combo boxes, or edit fields, I use those as landmarks on the page to get to the information that I need to get to faster."

3.4 Resource Finding

Participant 1 shared that she "wish(es) there (was) a way for people to access information that is specific to people with disabilities, whether it's programmed to help support buying a home, or accessing investments, or financial

literacy in general." There are many online sources for investment information, but there's no "hub in a way…or organizations associated" (Participant 1) for people with disabilities to access investment information easily.

We asked the participants what resources that they use to access investment knowledge information. Below is a table of sources.

Table 2: List of sources used to find investment information

Source	Description
Websites	BARD (Braille and Audio Reading Download), Kiplinger's Personal Finance, Kiplinger's Retirement, Investor's Business Daily, Newsline from Library of Congress, Investors club, Motley Fool, Nerdwallet, Bloomberg, Yahoo Finance, CNBC Finance
Videos	YouTube
People	Family, friends, spouses, financial advisors
Paper items	Investing 101 Book, Newspapers
Audio	Newsline telephone calls, WBBM Newsradio, Bloomberg radio
Other	Phone alerts, ex: Google notifications

3.5 Investment Fees

Unexpected investment fees were a common complaint among our participants because they express that it becomes expensive to make investments when they need to use outside help. With "Vanguard, they (used to make trading) easy, but then they start(ed) adding in fees. Now, if you want to call instead of doing it on your own, there are more fees" said Participant 4. They also shared that they "have to call and…would have to pay $25 for a trade or to (get a question answered)" (Participant 4). As a result of incurring fees when calling a customer representative for assistance, our participants prefer to make investment decisions on their own rather than call a customer service representative.

3.6 Emotions

Our participants expressed a lack of trust issues with the financial system because of the complexity of investing, the lack of resources, and screen readers being unable to retrieve the required information to perform a financial transaction. Other stressors include the volatile stock market, hackers, fear of moving their assets to a new investment system that may be less accessible, and fear of losing their government benefits. Since many people who are blind are unemployed or living on a fixed income, they have less tolerance for risk because they have less discretionary income to allocate to investments.

3.7 Security

Our participants mentioned issues with security. Examples include identity theft of their social security and account information, and so having to distribute their investments amongst multiple apps to not have all of their money in one place. Participant 1 shared her concerns, "Security would be the first thing and just the trust that comes with that. So for me, if you're making an investment, you've got to connect it to your bank account if you're purchasing mutual funds or stocks or anything like that. So there's the process of getting your routing information and your account numbers and giving it away and often seems to involve your social security number."

3.8 Understanding Financial Concepts

Participants reported feeling "overwhelmed" when trying to comprehend financial concepts from various sources before making investment decisions. Participant 1 stated, "I tried to educate myself, but it's a bit overwhelming. So I downloaded that app that has these like bite-sized lessons on financial literacy." Two participants acknowledged that reading mutual fund prospectus' is something they "should do" but they did not because the content was "daunting." Participant 4 shared frustration when trying to understand information on schwab.com. He stated, "The information just seems very, very complex and I was reading through the explanations but had a difficult time conceptualizing it." Participant 3 recalled, "And some of the sighted people who I would rely on for help, are not very familiar with investing themselves. And so as a consequence of that, they're not necessarily able to interpret the chart even where I just show them what I wanted them to, to explain to me."

4 DISCUSSION

The purpose of our research was to find barriers that individuals who are blind face in accessing and managing their financial investments and wealth-building practices. We conducted interviews with five people who are blind, then analyzed the collected data to find common pain points.

The most significant challenge with accessing financial information for investments is that screen readers are not deciphering and interpreting visual financial data accurately for users who are blind. Visual data includes graphs, charts, and tables. The inaccessibility of visual financial data for screen reader users results in a significant accessibility gap between sighted and blind individuals. These findings are important in the context of existing literature. According to Rooij et al. the association between advanced financial literacy and wealth accumulation is not only statistically significant but is also quite large. Assisting the blind to access information supports them in making informed financial discussions and is critical to their financial success. Significant variations in financial intelligence correlate with essential differences in financial behavior [11].

All participants required someone to assist them in making important financial decisions at some point. They explained that they need to spend much more effort than sighted people to gather and analyze necessary information to make investment decisions.

Participants reported challenges accessing both online and offline financial information, including data visualizations that their screen reader could not interpret and paper-based documents such as loan applications and bank statements. These findings are supported by our research which shows the benefits of taking a multi-modal approach to mitigating accessibility issues.

People who are blind use braille and employ their sense of touch to help them navigate the world [7]. Data in charts can be visualized through textures to help people distinguish differences and make comparisons among datasets [7]. The study conducted by Scariot et al. recommends using haptic charts by employing different vibration frequencies to distinguish between lines. Different colors can be signified when making audio get louder and softer, or faster and slower.

Our participants expressed positive feedback for Robinhood's audible graphs as a tool that helped them understand stock market trends through ascending and descending tones. The research findings of Safina et al. also indicate that modulations in pitch helped make data more accessible in two-variable linear graphs of stock prices. Finally, Zou and Treviranus developed "ChartMaster" which creates a text summary of data points from the stock market charts, which is then read out by screen reader software. This tool can be best utilized for blind individuals who want to be able to translate visual data into words.

4.1 Recommendations

Based on our findings, we generated technical and design recommendations driven by the needs of users who are blind. We recommend the following to improve the accessibility and usability of financial data on the website:

- Visit the accessibility HTML codes used in structural elements to help screen readers provide contextual page information to their users.
- Determine a way to incorporate narrative summaries into tables, interactive charts, and pages accessible only by screen readers.
- Ensure that tables on a webpage are created to leverage proper ARIA labels.
- Ensure that the website follows proper structural labeling of headers, navigation elements, tabs, figures, and buttons.
- There needs to be a "central hub" that's accessible for people with disabilities. It could have different categories: insurance, government instructions, applications.
- Investment services and products should have audio graphs for users who are blind. Audio can be added to data like graphs, charts, and tables.
- Easier access to market recommendation systems that indicate buy/sell/hold.
- To provide easy access to a human when completing an investment transaction.
- Incorporate haptic and tactile feedback such as a user interface with textural patterns and vibration into charts and graphs to help distinguish between data points.
- Ensure that all charts and graphs are implemented with audio graph technology like Audio Graphs API from Apple (https://developer.apple.com/documentation/accessibility/audio_graphs) making them more accessible to screen readers.
- When building voice interfaces having options to summarize a holistic view of a company data including price, trends, buy/sell recommendations.
- Simplify and break down complex financial concepts and terminology into manageable "chunks" phrased at an eighth grade reading level so that people can more easily grasp the information.

4.2 Limitations & Future Work

Our study was limited by our small sample size and may not represent most of the struggles that users who are blind face. The participants in this study are experienced investors who are over the age of 30. For future studies, we would recruit a large participant pool that includes mainly novice investors and users who are in their twenties, to discover barriers they may face when beginning their investing journey. Additionally, we would use some of the above implications for design to develop a tool that is accessible to all.

REFERENCES

[1] Ali Safinah, Muralidharan Laya, Alfieri Felicia, Agrawal Monali, Jorgensen Jacob. 2020. Sonify: Making Visual Graphs Accessible. In: Ahram T., Taiar R., Colson S., Choplin A. (eds) Human Interaction and Emerging Technologies. IHIET 2019. Advances in Intelligent Systems and Computing, vol 1018. Springer, Cham. DOI: https://doi-org.ezproxy.depaul.edu/10.1007/978-3-030-25629-6_70

[2] Ana Paula Scariot, Luis G. Montané-Jiménez, and Carmen Mezura-Godoy. 2021. Towards the creation of accessible charts for the visually impaired. In XXI International Conference on Human-Computer Interaction (Interacción 21), September 22–24, 2021, Málaga, Spain. ACM, New York, NY, USA, 5 pages. DOI:https://doi.org/10.1145/3471391.3471425

[3] Anon. 2021. Disability & Socioeconomic Status. (2021). Retrieved October 15, 2021, from https://www.apa.org/pi/ses/resources/publications/disability

[4] Ather Sharif, Sanjana Shivani Chintalapati, Jacob O. Wobbrock, and Katharina Reinecke. 2021. Understanding Screen-Reader Users' Experiences with Online Data Visualizations. In The 23rd International ACM SIGACCESS Conference on Computers and Accessibility (ASSETS

'21). Association for Computing Machinery, New York, NY, USA, Article 14, 1–16. DOI:https://doi.org/10.1145/3441852.3471202

[5] Hong Zou and Jutta Treviranus. 2015. ChartMaster: A Tool for Interacting with Stock Market Charts using a Screen Reader. Proceedings of the 17th International ACM SIGACCESS Conference on Computers & Accessibility - ASSETS '15 (2015). DOI:http://dx.doi.org/10.1145/2700648.2809862

[6] Hong Zou and Sambhavi Chandrashekar. 2016. ChartMaster: A Tool for Promoting Financial Inclusion of Novice Investors. In: Antona M., Stephanidis C. (eds) Universal Access in Human-Computer Interaction. Users and Context Diversity. UAHCI 2016. Lecture Notes in Computer Science, vol 9739. Springer, Cham. DOI:https://doi.org/10.1007/978-3-319-40238-3_17

[7] Jason P. Fritz and Kennth E. Barner. 1999. Design of a haptic data visualization system for people with visual impairments. IEEE Transactions on Rehabilitation Engineering 7, 3 (1999), 372–384. DOI:http://dx.doi.org/10.1109/86.788473

[8] Jing Jian Xiao and Barbara O'Neill. 2020. Disability type, financial capability, and Risky Asset Holding. Journal of Disability Policy Studies (2020), 104420732098178. DOI:http://dx.doi.org/10.1177/1044207320981781

[9] Judy T. Lin, Christopher Bumcrot, et al. 2019. The State of U.S. Financial Capability: The 2018 National Financial Capability Study. (2019). Retrieved October 24, 2021 from https://www.usfinancialcapability.org/downloads/NFCS_2018_Report_Natl_Findings.pdf

[10] Katherine Anne Dahlem. 2010. Attitudes to Savings and Financial Education Among Disability-Related Population Groups: Findings from the Financial Literacy Focus Groups (Oct. 2010). http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.369.6291&rep=rep1&type=pdf

[11] Lynn A. Blewett, Julia A. Rivera Drew, Miriam L. King and Kari C.W. Williams. IPUMS Health Surveys: National Health Interview Survey, Version 6.4 [dataset]. 2019. Retrieved October 24, 2021 from https://www.afb.org/research-and-initiatives/statistics/adults. DOI:https://doi.org/10.18128/D070.V6.4

[12] Maarten CJ van Rooij, et al. 2012. Financial Literacy, Retirement Planning and Household Wealth. The Economic Journal (London), 122(560), 449–478. DOI:10.1111/j.1468-0297.2012.02501.x

[13] Nanette Goodman, Bonnie O'day, and Michael Morris. 2017. Financial capability of adults with disabilities. 2017. Retrieved October 15, 2021 from https://www.nationaldisabilityinstitute.org/wp-content/uploads/2019/01/ndi-finra-report-2017.pdf

[14] Rakhi Dandona. 2001. "Socioeconomic Status and Blindness." British Journal of Ophthalmology, vol. 85, no. 12, 2001, pp. 1484–1488., DOI:https://doi.org/10.1136/bjo.85.12.1484

[15] Tullio Jappelli and Mario Padula. 2013. Investment in financial literacy and saving decisions. Journal of Banking & Finance 37, 8 (2013), 2779–2792. DOI:http://dx.doi.org/10.1016/j.jbankfin.2013.03.019