DebtFreeMe - Helping Individuals Manage Debt Using Mobile Technology

An Interactive Qualifying Project Report Submitted to the Faculty of WORCESTER POLYTECHNIC INSTITUTE in partial fulfillment of the requirements for the Degree of Bachelor of Science

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ABSTRACT

Credit card debt is a major concern worldwide, and it is unclear which strategies are effective in keeping households motivated to pay such debts. To tackle this issue, we have developed a prototype mobile application that delivers debt management strategies as interventions. Our application introduces one new debt management strategy that ranks debts by emotional burden and one established repayment strategy. The application will be used for research that compares these two strategies. We iteratively developed the prototype following user-centered design principles, starting with a paper wireframe followed by a fully functional Figma prototype. We interviewed potential application users to refine the prototype software developers can use to create the application.

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EXECUTIVE SUMMARY

Debt and financial worries significantly impact individuals' mental health. Having high debt could lead to conditions such as depression and anxiety, which can affect the person's ability to manage their finances (Drentea, 2000). Conversely, mental health conditions like depression can impair financial management abilities, leading to higher debt levels (Debt and Mental Health, 2021). Poorer mental health is associated with increased financial stress, and persistent economic hardship can worsen mental health. Breaking this cycle often requires specialized debt reduction strategies.

Consumers use different strategies to pay their debt. Some strategies are more useful in keeping them motivated in their attempts to repay their debts. One common strategy is the snowball strategy, popularized by financial guru Dave Ramsey, which involves paying off debts from smallest to largest while maintaining minimum payments on all debts. Once the smallest debt is paid off, the freed-up money is redirected to the next smallest debt, creating a snowball effect. This process continues until all debts are fully repaid. While this strategy has been helpful, it does not consider consumers' emotions regarding each debt. The sponsors are looking to develop an application to test a new debt repayment strategy and compare it to the debt snowball strategy to see if considering consumer emotions in debt payment would increase their motivation to pay down their debt.

We have built a prototype application to facilitate research on the snowball method and a novel debt management method based on emotions. The research will introduce a new debt management method and assess its effectiveness. The new method will rank a person's debts by their subjective emotional burdens, and they will be paid off in the order from most to least emotional burden. A custom mobile application must be created to facilitate this research, along

with a database for user and research data and a web-based application for administrative purposes. Once completed, this application will help facilitate research into better debt management.

We developed the prototype over several stages using user-centered design approaches, beginning with a paper wireframe and then building a complete user experience (UX) prototype using Figma. We then conducted interviews with potential users to identify issues with the design and iteratively improved the prototype based on the findings. These interviews proved highly effective, adding an entirely new section of the prototype and major redesigns of the user interface.

1 - INTRODUCTION

At the end of 2022, American household debt reached an astonishing $16.9 trillion (Household Debt and Credit Report, 2023). This massive debt burdens the country's economy and individuals, with the average total debt balance per American at $101,915 in 2022 (Horymski, 2023). Debt can help individuals finance their long-term goals or afford short-term needs. Debt can be a powerful tool when used responsibly and managed effectively (Pyles, 2023). However, for many individuals, debt can quickly spiral out of control (Tavin, 2023). When it does, it can become an overwhelming burden that threatens or destroys their financial well-being, draining their bank accounts and leaving them feeling helpless and powerless.

Debt and financial concerns impact individuals and households globally. Financial difficulty can influence many aspects of an individual's life, such as their mental and emotional well-being, family dynamics, and overall quality of life. Hence, managing debt is crucial for people's overall well-being.

Various debt management strategies were developed to address this problem. One such strategy is called the debt snowball. Debt snowballing chooses which debts to pay numerically to generate bursts of positive feedback each time a debt is paid off (Amar et al., 2011). This is the most popular strategy with a basis in emotions. The debt snowball was created by financial guru Dave Ramsey (Ramsey Solutions, 2023). This method involves the individual ordering their debt from smallest to largest and putting as much of their payments as possible towards the smallest debt while making minimum payments on the rest (Ramsey Solutions, 2023). Once the individual has paid off the smallest debt, they should enjoy a sense of accomplishment and use this motivation to keep going (Wells Fargo, 2023). As the individual finishes paying off debts, they will take all the money they were paying on that debt and move it to the next smallest debt

(Ramsey Solutions, 2023). This is added on top of the minimum payments, creating the 'snowball' effect from which it gets its name.

In this project, the sponsor wants to introduce a new emotion-based debt management strategy and conduct research on it. Although the debt snowball utilizes human emotion and motivation, it does so indirectly through a sense of satisfaction upon erasing debt, whereas the sponsor wants to introduce a new method that directly addresses a person's emotional burdens connected to their debt. Consumers likely have negative emotions such as psychological burden, pain of payment (Reshadi & Fitzgerald, 2023), or guilt associated with their debts. However, the level of burden attached to each debt can differ. In this proposed strategy, people rank their debts by emotional burden, from the most to the least hated, and pay off each debt in this order while making minimum payments on the rest. Once a debt is paid, any money previously spent on it is carried over to the next debt in the ranking. In contrast to the debt snowball method, this approach chooses which debts to pay emotionally, channeling a constant stream of motivation as the debts are paid.

This new method addresses one of the major flaws of the debt snowball. The debt snowball assumes that fully paying off any debt will provide sufficient motivation to continue paying off remaining debts. However, this is not necessarily the case, as debts may or may not be emotionally charged, and not all will generate the same motivation. By explicitly targeting debts with the heaviest emotional burdens, our approach will encourage greater commitment, strengthening their motivation to continue working towards eliminating their debt.

This project aims to develop a mobile application to help consumers track and manage their debt accounts using one new and one existing debt payment strategy. The proposed application will leverage consumer behavior and social psychology theories to help individuals

use emotion-based debt repayment strategies to manage their debts. The application provides a personalized and effective way to help individuals manage their debts and improve their financial well-being. At the same time, this new application will facilitate testing the effectiveness of multiple strategies in future research studies.

2 - BACKGROUND

2.1 - Debt in the United States

The American people owe over $986 billion on credit cards, $1.55 trillion on vehicle loans, $1.6 trillion in student loans, and an astonishing $11.92 trillion in mortgages (Household Debt and Credit Report, 2023). Even worse than these totals are the estimates for individuals. According to a study conducted by the credit reporting agency Experian, the average total debt balance for an American in 2022 was about $101,915 (Horymski, 2023). This contrasts with the median household income of $70,784 reported by the 2021 US census (Semega & Kollar, 2022). If these numbers belonged to a single individual, their debt-to-income ratio would be a staggering 144%, a number aligned with current statistics. The US Federal Reserve estimates that in the first quarter of 2023, the average American had a debt-to-income ratio between 133% and 176% (EFA: Household Debt, 2023). On the other hand, many banks and financial advisors consider 35-36% as the upper limit of a ‘good’ debt-to-income ratio (Folger, 2023; Goldman, 2023; Lowe, 2023; Opperman, 2023; Push & Ceizyk, 2023; Sellner, 2023; Wells, 2023). American household debt, including credit card debt, vehicle loans, student loans, and mortgages, is extraordinarily high, while the median household income is much lower. This indicates that many Americans are in an unhealthy state of debt, with a high debt-to-income ratio, and likely struggle to pay it all back.

2.2 - Debt and Mental Health

Taking on debt can impact an individual’s mental and emotional well-being. It’s crucial to understand that debt is not just a financial burden, but it can also weigh on the debtor’s mental health. In a study on anxiety, it was reported that debt had a significant association with anxiety

(Amit et al., 2020). Credit Union members of low-income households had a higher rate of anxiety compared to the Northern Ireland average; 11.5% of the participants described themselves as anxious or depressed, and 23.5% were receiving treatment for anxiety or depression (Amit et al., 2020). These findings show that there is a connection between debt and health. Debt is linked to anxiety, which can harm a person's health. This highlights the need for effective debt management and research to improve debt management strategies.

The National Institute on Alcohol Abuse and Alcoholism conducted a survey across the years 2001-2005 called the National Epidemiologic Survey on Alcohol and Related Conditions. Elbogen et al. (2020) investigated the data generated by this survey and found that financial strain contributes to suicide risk. Specifically, unemployment and low income showed a statistically significant association with suicide rates (Elbogen et al., 2020). These findings suggest that not only can financial strain affect mental health, but it can do so with potentially dangerous severity.

Drentea and Reynolds (2015) tested debt's role as a money-related stressor and found that indebtedness directly elevates depressive symptoms compared to debt-free adults. For some people, this could lead to lasting mental health problems and means debt could contribute to the country's ongoing mental health crisis. The same study also found that debt was ineffective as a buffer against the mental health stress caused by unexpected economic hardship (Drentea & Reynolds, 2015). For example, the COVID-19 pandemic created a financially and mentally stressful situation for many people. A CNBC survey found that almost a quarter of Americans took on debt during the pandemic to pay for basic necessities (Leonhardt, 2019). While taking on debt may temporarily alleviate some financial burden, Drentea and Reynolds (2015) suggest that such tactics would not reduce the mental stress of the situation. Finally, the study also concluded

that the stress caused by debt could not be significantly mediated by social support or social mastery, which contrasts with general economic hardship (Drentea & Reynolds, 2015). This means that, unlike economic hardship, having a strong social circle does not lessen the effects of debt stress. This leaves indebted people with few options to mitigate the harmful mental health effects.

2.3 - A Vicious Cycle

The link between mental health and debt works in the other direction, too. Mental health conditions such as depression are known to affect a person's ability to manage their finances (Debt and Mental Health, 2021). People suffering from mental health problems in England were found to have debt problems at three and half times the rate of those without mental health issues ("Debt and Mental Health," 2019). These problems can feed off each other, forming a cycle of financial difficulty and poor mental health.

A study published in 1986 by Aldwin and Revenson found that people in poorer mental health were more likely to report financial stress. The study also found that persistent economic hardship worsened the mental health of those who were healthy but did not significantly affect people who were already in poor mental health (Aldwin & Revenson, 1986). Overall, this supports that a spiral effect can occur, forming a challenging cycle to break free from. In the absence of charity from organizations, friends, or family, specialized debt reduction strategies are often needed to break such a spiral.

2.4 - The Debt Snowball

Consumers use different strategies to pay their debt. Some strategies are more useful in keeping them motivated in their attempts to repay their debts. A highly popularized strategy is the snowball strategy, characterized by paying off debts in order from the smallest to the largest

balance (Ramsey Solutions, 2023). Although the spotlight is on the smallest debt, the strategy includes paying the minimum payments for all debts (Kagan, 2023). After paying off the smallest debt, the money previously focused on it can be shifted to the next smallest. This is added to the minimum payment, creating a snowball-like effect (Ramsey Solutions, 2023). This strategy is repeated until all debts have been paid in full. The debt snowball method was made famous by Dave Ramsey, a financial guru, author, and radio host (Cassell Jr., 2022). While more efficient strategies exist in theory (see 2.6), the debt snowball is the most effective strategy in practice (Trudel, 2016). Functionally, human emotion and motivation are as important as mathematics.

2.5 - A New, Emotion-Based, Debt Management Method

The debt snowball method is generally believed to be effective because of the motivational effects of eliminating debt accounts (Brown & Lahey, 2015). However, despite substantial advocacy from financial advisors, it remains an uncommon strategy in real usage. A study of credit cards across 2013-2014 found that the most popular repayment method was balance matching, which pays off the highest balances first (Gathergood et al., 2019). Notably, this is the exact opposite of the debt snowball. Critically, most previous studies have proposed debt repayment strategies that sort consumers' debt accounts or suggest paying them off based on some monetary aspect of debt (e.g., minimum payment amount, balance amount, or proportion). Previous studies have overlooked the role of the emotional burden caused by a debt account. The emotional burden of a debt is the negative effect consumers experience when they think about a specific debt account. This effect could significantly affect consumers' motivations to repay their debts. For example, paying off a highly burdensome debt might increase repayment motivation more than paying off a low-burden debt due to releasing more mental

resources after repaying the debt. Thus, there is a need for developing an effective motivation-based method for credit card debt repayment.

The debt reduction strategy created for this purpose allows an individual to rank their debt based on emotional burden. This method allows debtors to pay off each debt from the greatest to the least emotional burden. Such a method would preserve the motivational aspects of the debt snowball method by prioritizing the most painful debts first. Still, it would also avoid working in the opposite direction of people's preferences.

2.6 - The Debt Avalanche

Another popular approach to debt management is the debt avalanche method, which involves an individual paying off debts from the highest interest to the lowest (Tardi, 2023). This method allows a debtor to pay off their highest-interest debts first, and once fully paid off, the money will be put to the next debt in the hierarchy (Tardi, 2023). Using this mathematically optimal method, the debtor will pay less in total interest over time (Tardi, 2023).

Our study will focus primarily on emotion-based management rather than mathematic management. Since the debt snowball method is more closely related, the debt avalanche method will not be included in the study. The approach of the debt snowball method and our emotion-based method do not prioritize the repayment of debt based on the interest rate. These methods utilize a ranking system that is designed to provide motivational boosts. In contrast, the debt avalanche method emphasizes paying off debt with the highest interest rate and is designed to minimize the total amount of money paid mathematically. The debt snowball is, therefore, a better analogy to our new emotion-based method and will be more useful as a comparison.

2.7 - Similar Applications

EveryDollar is an application that allows users to budget their money. It was created by Dave Ramsey Solutions (Farrington, 2022). EveryDollar is a budgeting application that follows Dave Ramsey's personal finance system (Farrington, 2022). In this application, the users can plan out their entire budget for the month. In budget planning, users can set how much money they plan to set aside for each item and category. With the budget planning done, users can set how much money they actually spent over the month. Users can see how much they have remaining for the final part of the budget. Next, the application has a transaction feature that tracks all income and expenses inputted by the user. Although EveryDollar allows connecting a banking account and automatically grabbing transactions, we decided this feature was not feasible for this project. We decided that adding a banking system to the application would be beyond the scope of the research performed with the application. Lastly, it has an insight feature allowing users to track different trends in their spending.

Observing the EveryDollar application gave us insight into how to design our prototype. From the budget section, we gained inspiration for the design of our information tables in our finance section. We also used a similar theming option of having the information displayed in a white box with a different-colored background. Lastly, we used the insight feature of the application as a guide for the progress section of our application.

2.8 - User-Centered Design

In developing our prototype, we adhered to user-centered design principles. User-centered design aims to create highly usable products by prioritizing convenience, effectiveness, manageability, and alignment with user requirements ("Usability," 2024). To incorporate user-centered design principles, we need to determine who the app's users will be, their tasks and

goals, and their experience levels with similar apps. Additionally, we need to know what functions the users need from the app and what information they need (Smith et al., 2004). Researchers identified several popular and effective ways of accomplishing these tasks, such as interviewing potential users (Vredenburg et al., 2002). By employing strategies like user interviews, it is possible to integrate user-centered design into a prototype effectively.

3 - METHODOLOGY

This project aimed to develop a custom prototype mobile application that can facilitate research into novel debt management techniques. We worked with the product owner and researcher, Professor Reshadi, to develop a list of initial design specifications based on her research requirements.

3.1 - Paper Wireframe

The prototype development process began with a paper wireframe model. We worked directly with the sponsor (Professor Reshadi) to draw out each page and view of the prototype on paper. The goal of the paper wireframe was to develop a list of initial design specifications based on the product owner's requirements. Drawn with pencil and paper, the wireframe was drafted and brought to the researchers several times until it provided a cohesive and complete vision for the application development.

3.2 - Figma Wireframe

The paper-based wireframe was implemented in Figma (*Figma*, 2023), a web tool for interface design, to allow us to collect user feedback. Switching to Figma made our design easier to present and allowed us to style the prototype to resemble the final design more closely. Transferring the wireframe from paper to digital helped us during the interviewing process so that interviewees had a better picture of what the application would look like. As the digital wireframe was correctly proportioned and more detailed, we were able to plan and develop the prototype better.

The application prototype contains sample entries. These sample entries enhance the prototype's understandability when shown to non-developers. All of the sample information is entirely fictional and has no basis in actual data.

3.3 - User Interviews

To further refine our prototype, we applied user-centered design strategies and interviewed potential users. These interviews aim to gather preliminary feedback on our app's design before development begins. We identified potential app users and interviewed them to learn about their perceptions of the app. We conducted these interviews using the digital wireframes before development to avoid unnecessary backtracking. Users were presented with digital wireframes during the interviews and asked questions about them. Before conducting the interviews, we sought approval from the WPI Institutional Review Board (IRB) to perform the interviews. WPI IRB protocol is on file (Protocol Number: IRB-24-0462).

Once the digital prototype had been developed, we began recruiting for potential user feedback interviews. Initially, we created flyers that were posted on social media platforms such as Facebook, Twitter, Reddit, and bulletin boards around WPI's campus. The flyer asked for volunteers to fill out a Google form so that we could verify their eligibility and obtain their email addresses (Fig. 1). Additionally, the form asked volunteers to place themselves in a range of debt amounts and household income, but these questions were for demographic purposes and were optional. The results of these forms are kept confidential and will be discarded upon project completion. The form can be found in Appendix A.

Unfortunately, no participants were successfully recruited using the flyers. Our social media posts were quickly taken down due to anti-advertising moderation. We ended up seeking out a convenience sample (our personal contacts) in order to proceed with the interviews. As a

part of this, we ensured that the participants were not recruited and interviewed by the same person and no participants had prior knowledge of the prototype. Ten interviews were conducted in total. Two were recruited through the WPI Potpourri list. The rest were personal contacts. Users were interviewed in three waves of three or four, with time between each set to make adjustments based on the feedback we received.

Volunteers were required to be over 18 years old. We attempted to use an additional criterion, which was that participants had held credit card debt for at least the past six months. However, this reduced the recruitment pool too much, so the requirement was dropped.

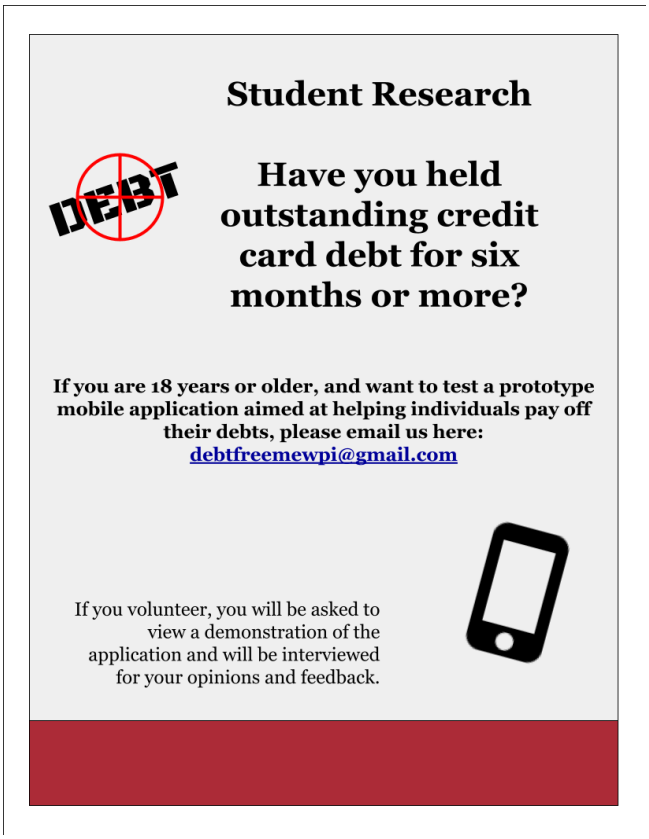

Figure 1: The recruitment flyer.

Ten people were interviewed over Zoom. The interviews were completely voluntary, confidential, and anonymous. No identifying information was gathered, and the data collected was not shared outside of the development team. All information collected during the interviews, including the audio recordings, will also be destroyed after the application development is completed. On average, interviews took 30 minutes. The interviews were audio recorded. Interviewees were asked to give verbal consent before the recording began. The interview consisted of an introduction, a

demonstration, and questions. Interviewees were asked for their overall thoughts on the prototype, how they thought the prototype looked visually, what features they thought should be added or removed, whether they thought the application would be helpful, and whether or not they believed they would pay for such an application.

The interview protocol, which can be found in Appendix B, was designed to fulfill the user-centered design goals of determining how users would interact with the app. After each set of interviews, we analyzed the data using a thematic analysis. We categorized the feedback we received according to the following themes: aesthetics, application flow, ease of use, explicit instructions, interview structure/clarity, major feature requests, minor feature requests, navigation, user freedom, and visual consistency. We discussed the feedback with the client and updated the prototype to address the client's and users' thoughts. The analysis of the most frequented themes helped us set effective priorities. This method allowed us to pinpoint specific parts of the wireframe design that did not resonate with the participants and minimize the number of changes during application development.

4 - RESULTS

4.1 - First Prototype on Paper

The application requires user accounts and authentication. Because financial information is sensitive, account access must be secure. Users need individual accounts so that all data can be attached to a research subject, and that data needs to be kept on record. These accounts will be premade for research participants. The first time a user logs into the application, they will need to agree to certain legal forms (Fig. C2).

The application had three main pages: the financial information screen, the research progress screen, and the settings screen (Fig. C3-C5). The financial information screen displays all the financial information the user enters into the application. This includes income and debt. Users can also add, edit, or delete their financial information. Additionally, users are able to view their information from previous months.

The research progress screen (Fig. C4) displays a message describing their progress and compliance with the research requirements. These messages will be automatically updated based on the information entered into the application. This will allow users to receive feedback on their performance and reminders if they fail to meet the research requirements (such as deviating too far from their assigned management method).

The settings page (Fig. C5) had the app's settings toggles and several sub-pages with additional information. The page had options to toggle each type of notification, reset the tutorial, access sub-pages, and log out. The sub-pages included a contact page, a feedback page, an about page (Fig. C6-C8), and links to the introduction videos. The contact page contains information about how to contact the research group. The feedback page allows users to send

feedback and suggestions. The about page includes information about the application itself, as well as any additional legal documents.

When an income is added or edited from the financial information screen, the add/edit income screen will be shown (Fig. C9). This screen has inputs to change the name of the income, the dollar value of the income, and the time period on which this value is repeated. Users can select from the time periods of monthly, semi-monthly, biweekly, weekly, hourly, and one-time. Certain choices of time period will require additional information, which will be inputted via a dynamic entry box (Fig. C10), which will ask for only the information needed.

The add/edit debt screen (Fig. C11) is shown when a debt is added from the financial information screen. This page has input fields for a name, starting balance, remaining balance, interest rate, category, minimum payment, and rank selector. The minimum payment section has two fields so that users can choose between dollar amounts or percentage-based minimums, depending on their debt structure. The rank selector asks two questions, allowing the user to rank the debt based on its emotional significance. Depending on the management method the user is assigned, this value may or may not be used in the future. Regardless, the questions are asked for consistency in research.

When an existing debt is edited from the financial information screen, the debt updater screen (Fig. C12) will be shown. This page displays the debt name and has input fields for the amount paid and interest rate. If the user wishes to change any other debt parameters, a button will take the user to the edit debt screen (Fig. C11), which will look the same as the add debt screen but without the ranking selectors at the bottom.

Each month, users will be asked to complete a monthly review. This review will gather updated information about the user's financial status. Once the review is started, users will be

shown the monthly review selector screen. If a user selects ‘Yes,’ then they will be taken to the monthly review income editor. If they select ‘No,’ then the income editor screen will be skipped and they will be taken to the monthly review income confirmation screen (Fig. C13-C15). The monthly review income editor will show a list of the user’s current incomes, which they will be able to edit, add to, or delete from. This will work similarly to the income section of the financial information screen, taking the user to the add/edit income page upon selection.

Once users finish or skip editing their income information, they will be taken to the monthly review income confirmation screen, which will display all the user’s incomes. The application will autofill income values based on the information about each income; however, in reality, these numbers can vary, so users can edit each number to reflect actual income.

After the user has completed the income section, the debt section will work similarly. Users will be asked whether their debt portfolio has changed. If a user selects ‘Yes,’ then they will be taken to the monthly review debt editor. If they select ‘No,’ then the debt editor screen will be skipped, and they will be taken to the monthly review debt confirmation screen (Fig. C16-C18). The monthly review debt editor will show a list of the user’s current debts, which they will be able to edit, add to, or delete from. This will work differently from the debt section of the financial information screen, taking the user directly to the add/edit debt page upon selection and skipping the update page.

Once users finish or skip editing their debt information, they will be taken to the monthly review debt confirmation screen, displaying all the user’s debts. The application will display the remaining balance on each debt and last month’s interest rate and autofill each monthly payment with that debt’s minimum payment. Interest rates can fluctuate, and some debts should be paid

more than the minimum, so these two fields will be editable. Once the user has completed this, they will be finished with the monthly review and will be taken to the research progress screen.

When a user logs on for the first time, they will need to complete some onboarding tasks. The first time a user logs in, instead of seeing the financial information screen, they will instead see the introduction video screen. After they have watched the video, they will complete an understanding check. If they fail the check, the correct answer will be shown, and the user will be offered the choice to rewatch the video (Fig. C19-C21). If the user passes the check, chooses not to rewatch the video, or finishes rewatching it, then they will begin their first monthly review. Certain aspects will be redundant at this stage, such as the question about whether or not their information has changed because they will not have entered anything yet at this stage, and those redundant pages will be skipped.

Once the user has finished entering their information, they will be taken to the method introduction video. They will be shown one of two videos, depending on which method they are assigned in the research. Just like the introduction, they will need to complete an understanding check after watching the video. If they fail the check, the correct answer will be shown, and the user will be offered the choice to rewatch the video (Fig. C22-C24). Once the user passes the check, chooses not to rewatch the video, or finishes rewatching it, then they will have completed the onboarding process and will return to the financial information page so that they may use the application normally.

4.2 - Second Prototype in Figma

When transferring the wireframe to Figma, we first used FigJam instead of a regular Figma design. FigJam is a digital whiteboard that a team can use to brainstorm, develop, and organize ideas (*FigJam*, 2023). We started with FigJam because it had a beginner's mobile

application template that we could use. With the use of the template, we were able to transfer all of the ideas from the paper wireframe into a digital format, which was easier to follow and accurately represented the vision for the product owner's vision for the application.

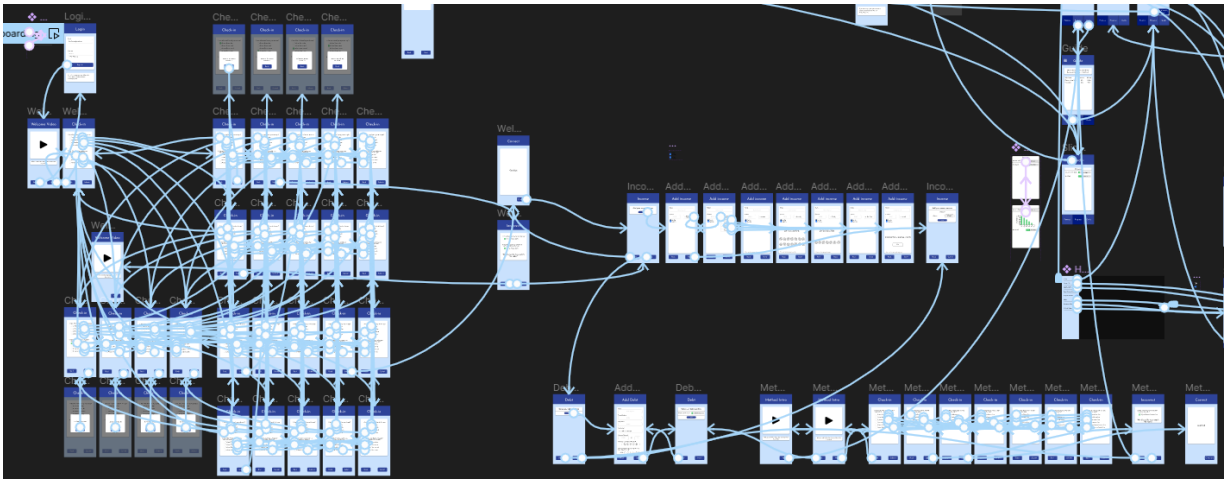

Figure 2: A view of the application flow in the onboarding section in Figma.

While FigJam worked well for transferring the wireframe to a digital format, it was not a perfect solution. FigJam is just an online whiteboard used for collaboration, so it does not have a presentation function like Figma design. Therefore, we moved our design prototype from FigJam to Figma design to allow the development of a functional prototype to be presented to potential users. The only hurdle we faced was related to the frames of the Figma design. In Figma, a container called a frame is used for a specific device or screen size. The frames being used are much smaller than what we had created during the first prototyping of the digital wireframe. So, as we fixed the issues we had with buttons, banners, font, icons, and theme colors, we also resized the different views the prototype had to fit the frames. By switching to Figma, we were able to create a prototype with some functionality using flows (Fig. 2-4). This allowed the prototype to emulate a user experience.

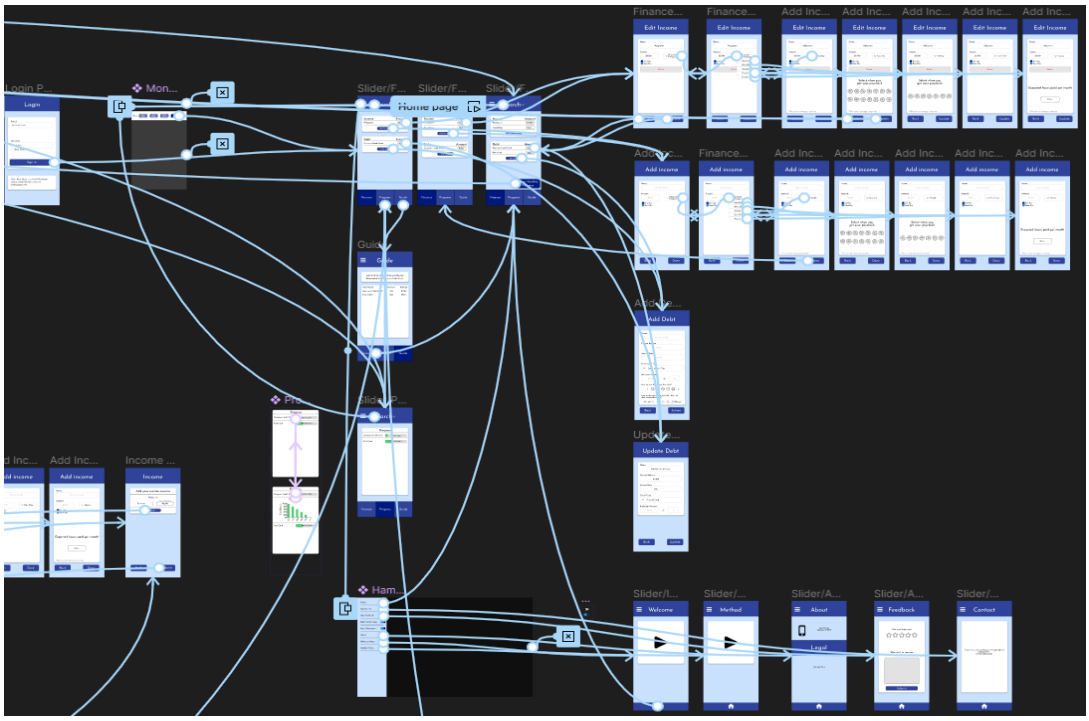

Figure 3: A view of the application flow around the main page in Figma.

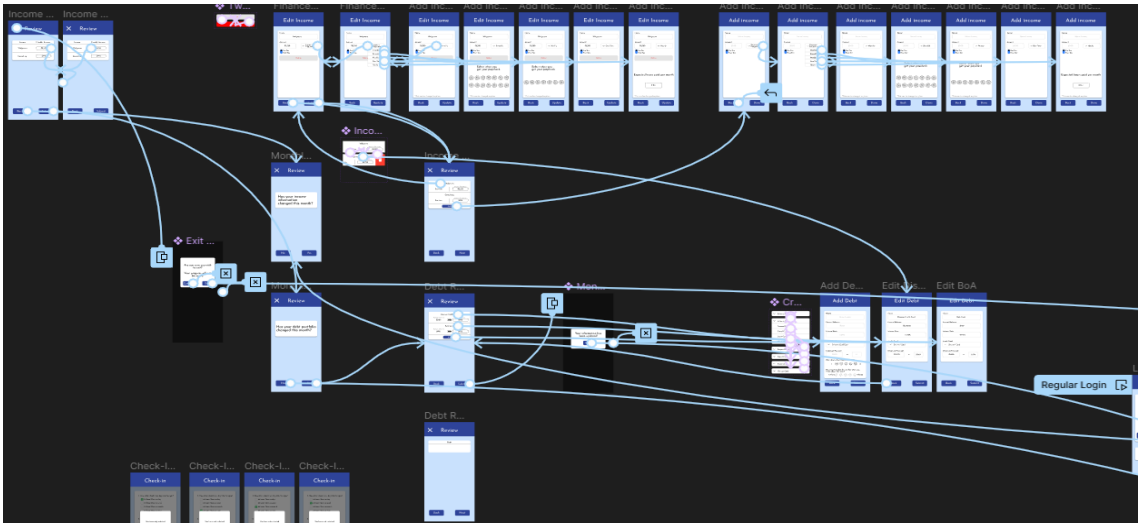

Figure 4: A view of the application flow in the monthly review section in Figma.

4.3 - Incorporating User Feedback and Creating a Third Prototype

Once the digital prototype had been developed, we began recruiting for potential user feedback interviews. Our social media posts were quickly taken down due to anti-advertising

moderation, so we sought out personal contacts in order to proceed with the interviews. Using the second prototype, we conducted three interviews to gather feedback on our design.

Throughout the interview rounds, we categorized the feedback we received according to its themes. The themes we used were aesthetics, application flow, ease of use, explicit instructions, interview structure/clarity, major feature requests, minor feature requests, navigation, user freedom, and visual consistency.

Theme	**Count**
Aesthetics	6
Application Flow	10
Ease of Use	11
Explicit Instructions	4
Interview Structure/Clarity	2
Major Feature Request	5
Minor Feature Request	3
Navigation	5
User Freedom	5
Visual Consistency	19

Table 1: This table shows the number of times we received feedback in each category across all of our interviews.

Overall, the most popular theme was visual consistency. The first prototype was not shown to potential users. For the second prototype, feedback was mostly about ease of use and navigation. This is due to oversights within the prototype's design. As the developers, we were very familiar with the prototype, so some features were not as obvious as we thought.

Theme	Count
Application Flow	1
Ease of Use	3
Interview Structure/Clarity	1
Navigation	3
Visual Consistency	2

Table 2: This table shows the number of times each category came up when gathering feedback on prototype 2.

Some participants mentioned that including a percentage with the debt progress bar would make the user feel more accomplished. So, we added percentage indicators to the debt progress page (Fig. D1). We changed the screen that shows when the user fails an understanding check to show the correct answers instead of the user's answers (Fig. D2). A participant wondered if they could revisit past months. We indicated this should be possible in the paper wireframe; however, this had not translated well into the electronic prototype, so we finished implementing the month selector so the user could revisit past months on the progress and financial information screens (Fig. D3). A participant mentioned that during the monthly review if they wanted to exit it, they couldn't. To rectify this, we added a button allowing users to exit the monthly review anytime (Fig. D4). In addition, some minor mistakes were fixed, such as typos.

One participant questioned the need for a legal prompt and noted that many apps do not have one. After discussing this with the researchers, we decided that the terms of service agreement and privacy policy would be signed before downloading the application, so the legal pages at the beginning of the onboarding were removed.

4.4 - Fourth and Fifth Prototypes

The interview and modification process was repeated twice more to produce two more iterative prototypes. Before the interviews on the third prototype, we changed our interview protocol to include more information about how the research affects the user experience. This alleviated some confusion from the interviewees about the research's relation to the application. Four interviews were conducted on prototype three.

We received much feedback about the app's appearance and aesthetics for the third prototype. This is likely because we made changes to improve the app's intuitiveness and the demonstration's clarity. This helped shift the focus of the interviews away from answering clarifying questions and more toward the app's features. However, the third prototype was not visually appealing, so the interviews' focus often gravitated towards these aspects. This makes sense because the visual aspects are obvious and easy to grasp. Additionally, we received suggestions for major and minor features. Although not numerous, these suggestions impacted the app's design more than other feedback.

Theme	Count
Aesthetics	3
Application Flow	2
Ease of Use	2
Interview Structure/Clarity	1
Major Feature Request	1
Minor Feature Request	3
Navigation	2
User Freedom	1
Visual Consistency	4

Table 3: This table shows the number of times each category came up when gathering feedback on prototype 3.

The progress bars continued to be a source of negative feedback, so we added dollar amounts to them to indicate more precise values (Fig. E1). We also discovered that we had forgotten to implement a way to remove incomes, so we added that (Fig. E2). We also cleaned up the income frequency selector so the user could cancel without selecting a frequency (Fig.E3). We condensed the debt review to one page. We had considered this for a while, and since some users brought it up, we decided to change it. Some functionality was lost, which would be addressed in prototype 5 (Fig. E4). In addition, we fixed some minor mistakes, such as a missing header, sample text, and color mismatches, as well as adding a “Show password” option to the login (Fig. E6).

For the fourth prototype, we revamped the whole prototype’s style. We changed the background color to pale blue and put all the content onto white cards, removing the sharp black outlines. We also changed all buttons to be rounded rectangles to match the cards. This made the prototype much more cohesive and more visually appealing.

We moved all the settings and related subpages to a hamburger menu. This freed up space on the bottom selector for a new page. In this space, we added a major feature, the guide page. This page displays the user's debt portfolio in a sorted list according to their assigned debt management method. It gives the user a recommendation on which debt to prioritize their payments (Fig. E7). Additionally, some checkboxes were swapped for toggle sliders (Fig. E5) at the suggestion of some users.

After a final round of three interviews, we made additional modifications to settle on a final prototype. For the fourth prototype, comments on visual consistency again dominated feedback. This time, it was a result of the style overhaul. Many remnants of the old layout still lingered around the prototype. While the interviews were helpful in spotting them, these visual inconsistencies tended to draw focus away from the app's features. This made it difficult to assess the effectiveness of the new additions, which included the major addition of a guide page. Interestingly, participants focused a lot more on the progress page in this prototype than previously, despite only minor changes. Every participant who viewed the fourth prototype suggested improvements to the progress page. We do not know if there was a specific reason for this collective attention to the progress page.

Theme	Count
Aesthetics	3
Application Flow	7
Ease of Use	6
Explicit Instructions	4
Major Feature Request	4
User Freedom	4
Visual Consistency	13

Table 4: This table shows the number of times each category came up when gathering feedback on prototype 4.

We changed the progress page to an expanding accordion-style menu. Tapping on an entry opens a bar chart displaying progress over time, a feature highly requested during our interviews (Fig. F1). We also discovered that we somehow lacked the option to edit income entries during the monthly review, so we linked the editor to the monthly review.

We changed the format of the debt review to display the previous month's balance (Fig. F2). This was a highly requested (N=3) feature during our interviews. We also condensed the income review to one page, adopting the new style from the debt review for visual consistency (Fig. F3). The one-page format was easier to use and more intuitive, so we decided to switch both the income and debt pages to this way.

We added two new credit card types (Fig. F4) in response to the request we received from the product owner. We also changed the process of deleting income entries to require confirmation to reduce the chance of accidental deletions (Fig. F5). We moved the exit button position for the monthly review to the top left to be more visually consistent with the rest of the prototype. Additionally, we added a popup to signal the completion of the monthly review (Fig. F6). We added a selector to the income creator to designate if an entry is pre-tax or post-tax. This

way, users can enter either for convenience. We also split the financial information screen into two cards, one for income and one for debt (Fig. F7). The visual separation helps with clarity. Finally, we changed the wording of many headers for clarity, fixed many styling oversights introduced when we overhauled the prototype style and fixed a few typos.

Additionally, it is worth noting that the volume of feedback increased over time. This is largely due to increases in our experience and skill when conducting the interviews and improvements to the interview protocol. As we conducted interviews, we became more practiced at explaining the application clearly and concisely and could better extract opinions within the same time frame.

5 - CONCLUSIONS

In this project, we developed a prototype mobile application that delivers debt management strategies as interventions. We used a user-centered design approach to develop the prototype. After developing a prototype based on the sponsor's needs, we interviewed potential users of the app to learn about their perceptions of the app and refined our prototyype based on their feedback. In the following sections, we will outline the limitations of our work, and will propose recommendations for refining and improving the prototype and developing the application.

5.1 - Limitations

Our work had a few limitations. First, we initially intended to recruit interview participants who held outstanding credit card debt through social media, however, we were not able to do so. Many major social media outlets we attempted to advertise on have strict policies against self-promotion. These policies were common on forum-like sites, including Facebook and Reddit, where posting our flyers without violating those policies was impossible. Additionally, some sites flagged our accounts as bots, likely due to the sudden influx of repetitive posts. Once flagged, any further flyers were immediately removed upon posting. Due to the difficulty of recruitment, we decided to refrain from social media recruiting and removed the qualifying criteria of holding outstanding debt for recruitments. Thus, the interview participants did not fully represent the target user demographic. Many interviewees did not carry credit card debt, which may have affected their feedback since their focus and priorities may differ from those who do carry credit card debt.

Another limitation was the software that we used. We built the application prototype using Figma, which carries some limitations. In particular, Figma does not support any database or back-end, so some features were impossible to implement in the prototype.

5.2 - Recommendations

Future work should consider and work around the limitations that we have encountered. Social media is not a reliable recruitment method. Researchers could use dedicated forums for research recruitment or pay for official advertising space on social media platforms. A better recruitment pool would also allow for a more definitive set of feedback since it would be possible to match the target demographic more closely.

We also strongly encourage those interested in using Figma to explore its features fully before creating prototypes. Initially, we missed a feature known as components, which allows developers to have interactive parts within a frame. If we had known about components from the start, it would have saved us significant time.

We also encountered some difficulties during the interviews that future researchers can avoid. Interviewees often expressed confusion about the research nature of the application because research is outside the scope of their general familiarity. It helps to spend more effort explaining how the research works before demonstrating the prototype. It is also ideal to avoid the use of generic placeholders for data. Creating sample text and sample entries with a fake story in mind makes the experience much smoother. If there are videos within the application, we suggest developers obtain samples and/or transcripts of those videos to embed in their prototypes.

Several desired features were not implemented in our prototype due to the Figma limitation mentioned earlier. One such feature would be offline data syncing, which would allow

users to use the application without an internet connection and then upload their data to the database once a connection is established. Additionally, the prototype was fixed in time. The full application should be able to revisit past months.

Our prototype should serve as a guide for developing a fully functional mobile application for this research. Additionally, using our prototype as more than just a guide is possible. Services such as Bravo Studio (*Bravo Studio*, 2023*)* can convert Figma prototypes directly into mobile applications. Such services could be utilized to give developers a significant head start. The lessons learned through our potential user interviews have allowed us to create an aesthetically pleasing and intuitive UX design, which should significantly accelerate the development time associated with the front end of this application.

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APPENDIX A

Demographics survey

This project aims to develop a mobile application for iOS and Android that can help consumers track and manage their debt accounts. The application will help users use emotion-based debt management strategies to manage their debts. It hopes to provide a personalized and effective way to help individuals manage their debts and improve their financial situation.
This demonstration will be conducted online via Zoom. It will take approximately 30 minutes, and no more than 60 minutes, and will involve viewing a demonstration of the application, followed by questions for your opinions and feedback.
The demonstration is completely voluntary, confidential, and anonymous. No identifying information will be gathered, and the data collected will not be shared outside of the development team. All information collected during the interviews will also be destroyed after the application development is completed.

Email*
Valid email
This form is collecting emails.

Is your age 18 years or older?*

- Yes
- No

Have you carried credit card debt for six months or more?*

- Yes
- No

Additional information
This information will help our study, but you are not required to answer. Your answers will not affect your eligibility to participate in the study.

Approximately how much credit card debt do you have?

- $0 - $2,000
- $2,001 - $4,000
- $4,001 - $6,000
- $6,001 - $8,000
- $8,001 - $10,000
- Greater than $10,000

Approximately, what is your annual household income?

- $0 - $20,000
- $20,001 - $40,000
- $40,001 - $60,000
- $60,001 - $80,000
- $80,001 - $100,000
- Greater than $100,000

APPENDIX B

Interview Protocol (60 min max. Need padding time in case of complications)

My name is Daniel (Giovanni), and I will facilitate this demonstration with my colleague Giovanni (Daniel). This interview aims to gather preliminary feedback on our app's design before development begins. Ultimately, this interview will help minimize setbacks and delays during the application's development. The interview is entirely voluntary, confidential, and anonymous. You may quit this demonstration anytime if you no longer wish to participate.

The demonstration will take approximately 30 minutes, and no more than 60 minutes, and will follow a designed interview protocol. We will give you a demonstration of the application, followed by questions for your opinions and feedback. We would like to record this interview for our research. We would record audio only. No identifying information will be gathered, and the collected data will not be shared outside the development team. All recordings and information collected here will also be destroyed after the application development is completed. If you prefer that we don't record this interview, we will have to slow our pace to take complete notes.

1. Do you have any questions?
2. If you agree with us recording this interview, please say, "I consent."
3. (If necessary, ask the interviewee to disable their camera)
4. (If the participant has given consent, begin recording)

The application we will show you today was developed for a group of researchers studying new and existing debt management approaches. Specifically, they are studying methods prioritizing the lowest balance first and prioritizing the greatest emotional burden first. The app's

goal is to help consumers manage their debt effectively while facilitating data collection for the research.

We will now begin the prototype demonstration. If you would like to take a break at any time or end the interview early, you may say so at any time.

(Begin the application demonstration; stop to answer questions as necessary)

- *Onboarding*
    - *Introduction video*
        - This video will introduce the experiment and explain that users will be expected to log in and update their debt portfolios each month.
    - *Introduction understanding check*
        - Because this is research, the researchers need confirmation that the user understands the research obligation.
    - *Introduction review*
    - *Initial financial information setup*
        -
    - *Methods video*
        - This video will explain to the user how the researchers want them to manage their debt. They will be shown one of two videos introducing one method that is part of the study based on the participant's research group. The approaches being studied are one that prioritizes debts with the lowest balance first and a method that prioritizes the debts with the highest emotional burden first. The video will explain in-depth how participants are expected to manage their debt.

    - *Methods understanding check*
    - *Methods review*

  (Stop for questions)

- *Finance/Progress*
    - *Login*
    - *Finance information screen*
    - *Add Income/Debt*
    - *Edit Income/Debt*
    - *Progress*
    - *Guide*

  (Stop for questions)

- *Monthly Review*
    - *Selector (income)*
    - *Income editor*
    - *Income confirmation*
    - *Selector (debt)*
    - *Debt editor*
    - *Debt confirmation*

  (Stop for questions)

- *Settings*
    - *Settings*
    - *Settings Subpages*

  (Once the application demonstration is complete, start the interview)

Do you have any questions?

(Continue once questions have been answered)

We will now begin asking feedback questions. We encourage you to give critical feedback since the goal is to identify issues and improve the prototype. If you do not wish to answer any of the questions for any reason, just let us know, and we will move past that question.

1. What do you think about the application overall? What do you like? What do you dislike?
    - Probe: Did anything confuse/annoy you about the app?
2. What do you think about the look and feel of the mobile app?
    - Probe: What do you think about the intuitiveness of the app?
3. How do you think this application could help you manage your debts?
4. Would you use this application if it was not offered for free?
    - Probe: Would you use this application if it was offered for free?

Let's look more closely at [Section] (Home, Review, Onboarding). (Repeat for each section)

1. What do you think about this section? What do you like? What do you dislike?
    - Probe: What confused/annoyed you about this section?
2. Are there any other features you think should be added to this section?
    - Probe: Are there any features you expected to see but did not find?

- Is there any other feedback about any part of the application that you would like to add?
- If you don’t mind us asking, where did you hear about us?

Thank you for your participation. We appreciate your feedback and thank you for your time.

APPENDIX C

Prototype 1 - Paper Wireframe

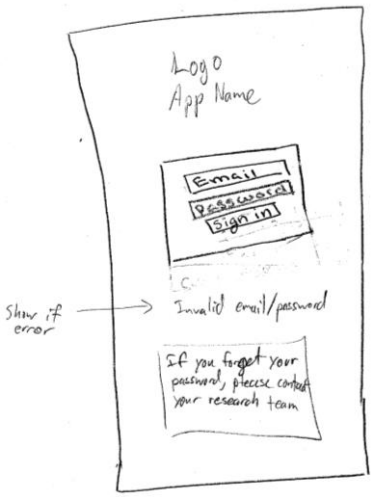

Figure C1: The login screen.

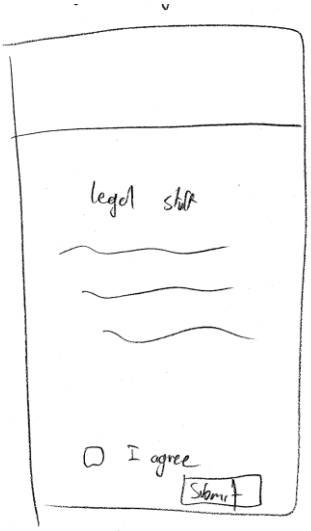

Figure C2: A template screen for any legal forms.

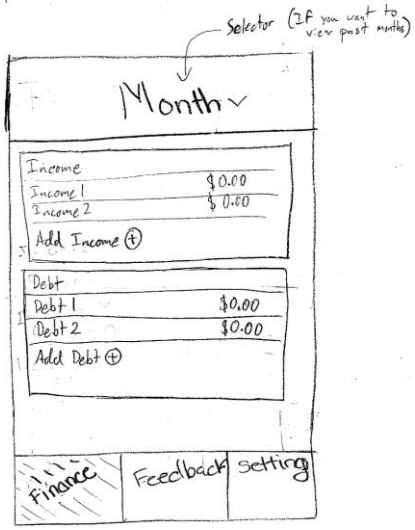

Figure C3: The financial information screen will display all the financial information that the user enters into the application.

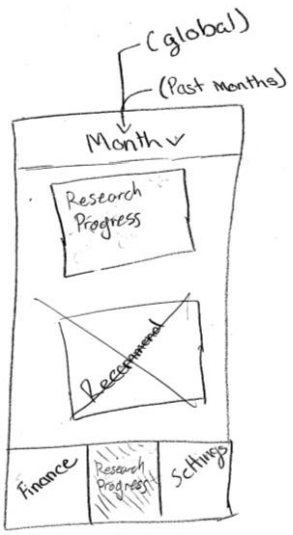

Figure C4: The research progress screen will display a message describing their progress and compliance with the research requirements.

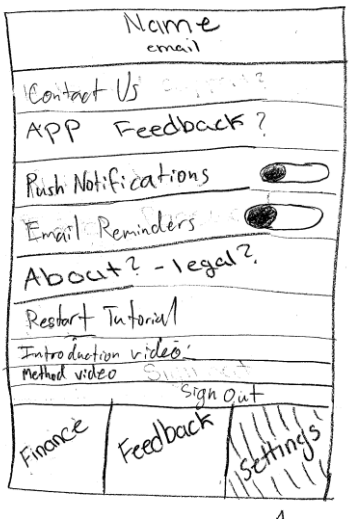

Figure C5: The settings menu.

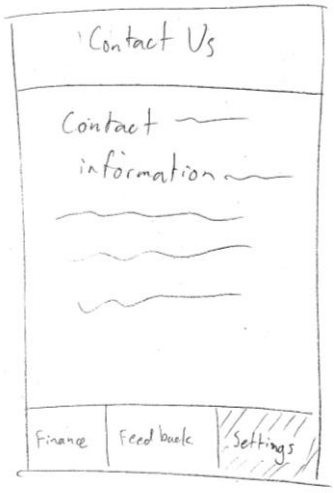

Figure C6: The contact information screen will contain information about how to contact the research group.

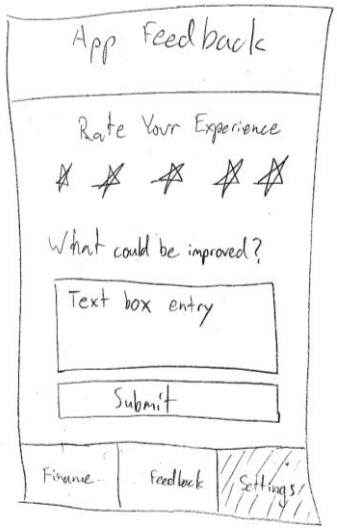

Figure C7: The feedback screen will allow users to send feedback and suggestions.

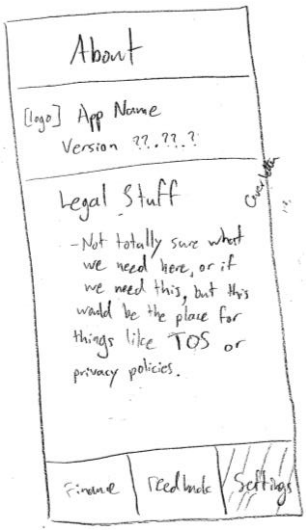

Figure C8: The About page will include information about the application itself, as well as any additional legal documents.

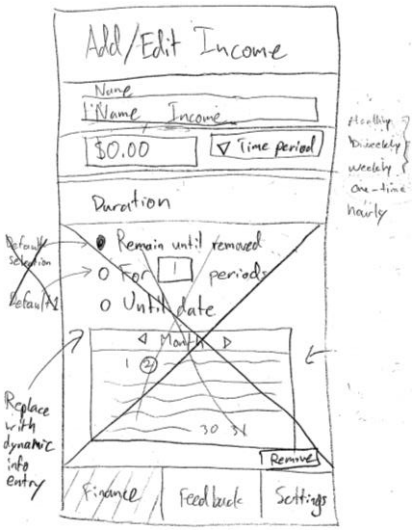

Figure C9: The income creator/editor screen allows users to create or edit their income sources.

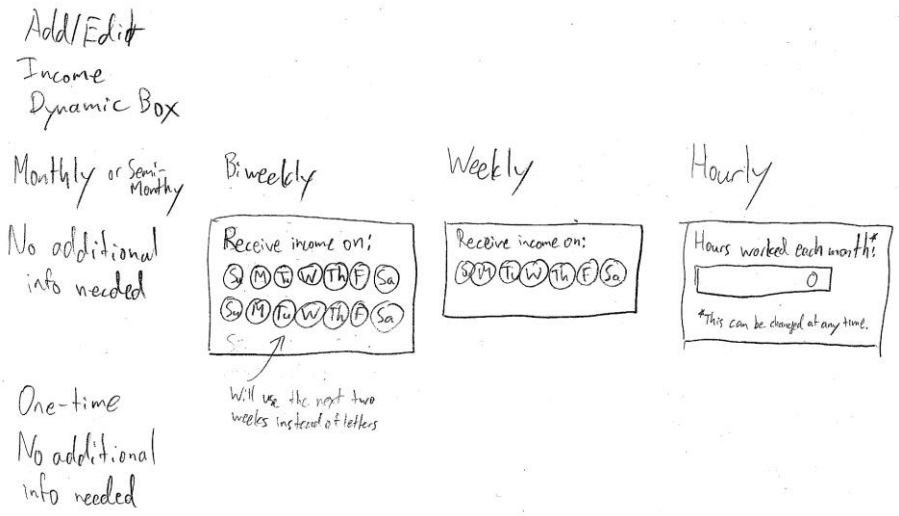

Figure C10: The dynamic boxes from the income creator/editor ask for information about the income's selected time period.

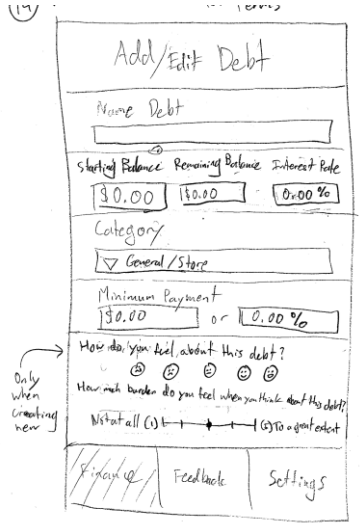

Figure C11: The debt creator/editor screen allows users to create or edit their debt entries.

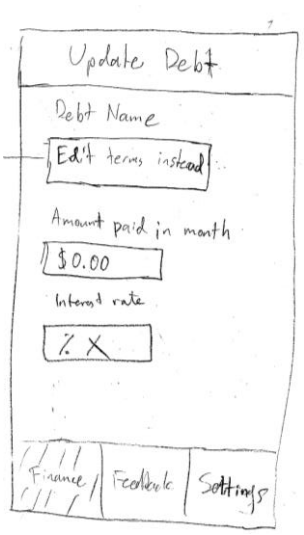

Figure C12: The debt updater screen allows users to quickly edit the basic attributes of the debt, as well as access the more detailed editor page.

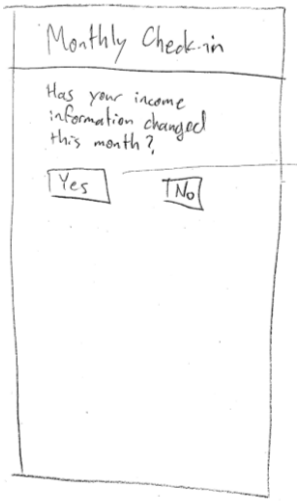

Figure C13: The monthly review selector screen.

Figure C14: The monthly review income editor screen will show a list of the user's current income sources. They will be able to edit, add to, or delete from the list.

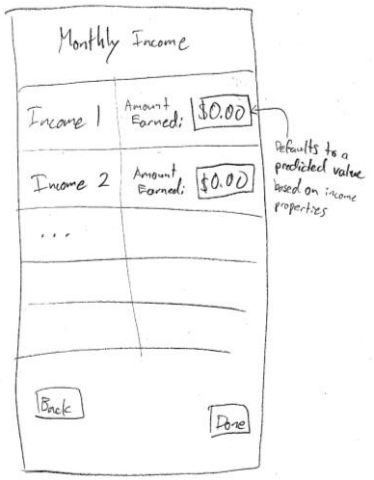

Figure C15: The monthly review income confirmation screen will display all the user's incomes. If their real income deviates from the expected value, they can adjust it here.

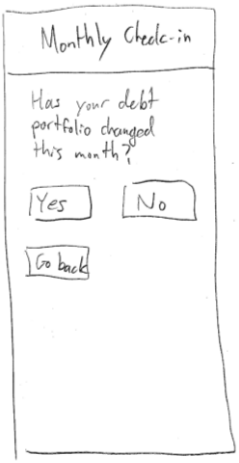

Figure C16: The second monthly review selector (debt) screen.

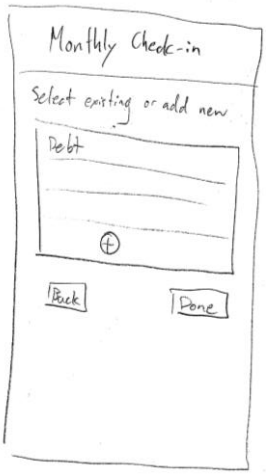

Figure C17: The monthly review debt editor screen will show a list of the user's current debts. They will be able to edit, add to, or delete from this list.

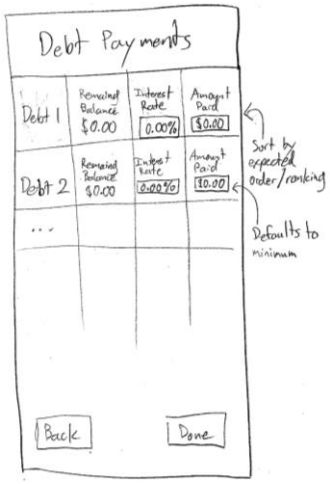

Figure C18: The monthly review debt confirmation screen will display all the user's debts. Here, the user can enter the amount they've paid in the current month and adjust interest rates if they fluctuate.

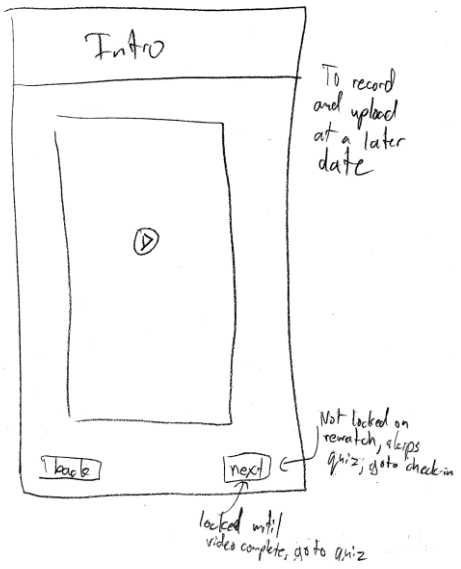

Figure C19: The introduction video screen.

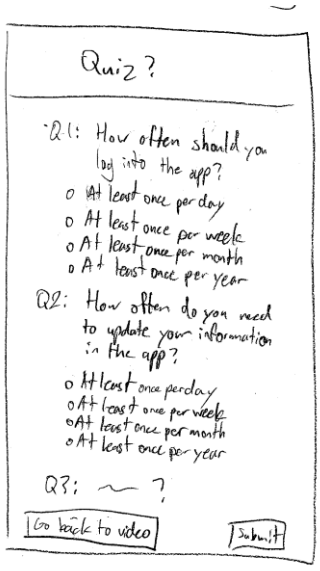

Figure C20: The understanding check screen for the introduction.

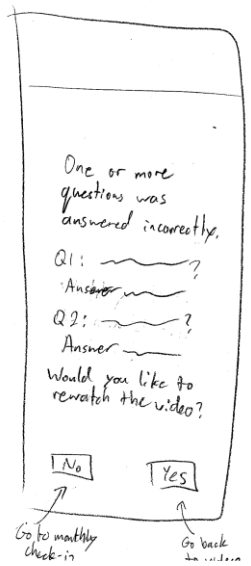

Figure C21: The review screen for the introduction.

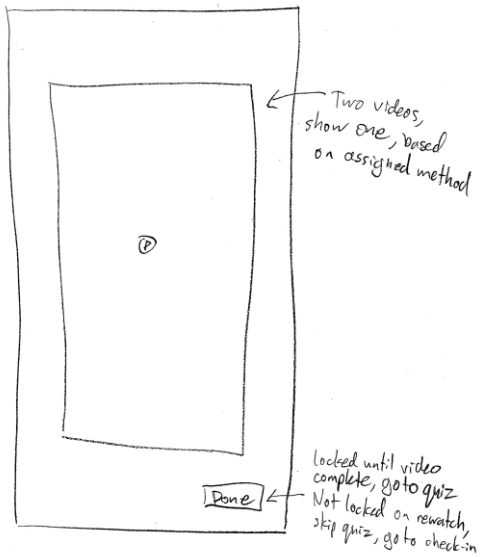

Figure C22: The methods video screen.

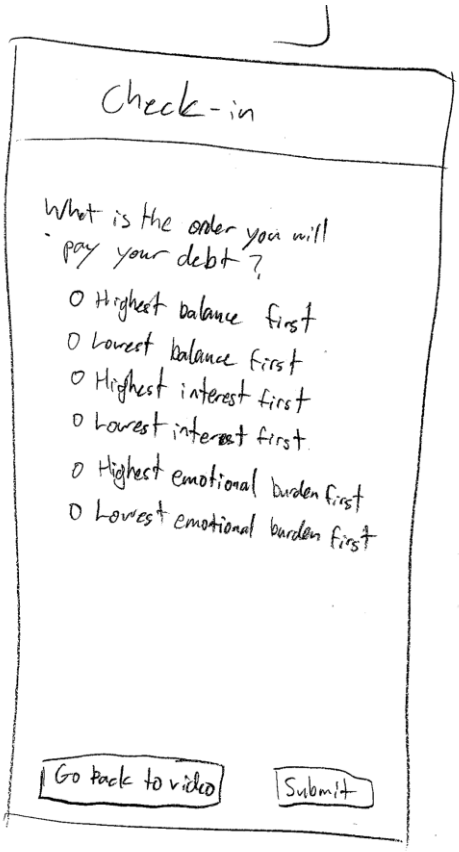

Figure C23: The understanding check screen for the methods.

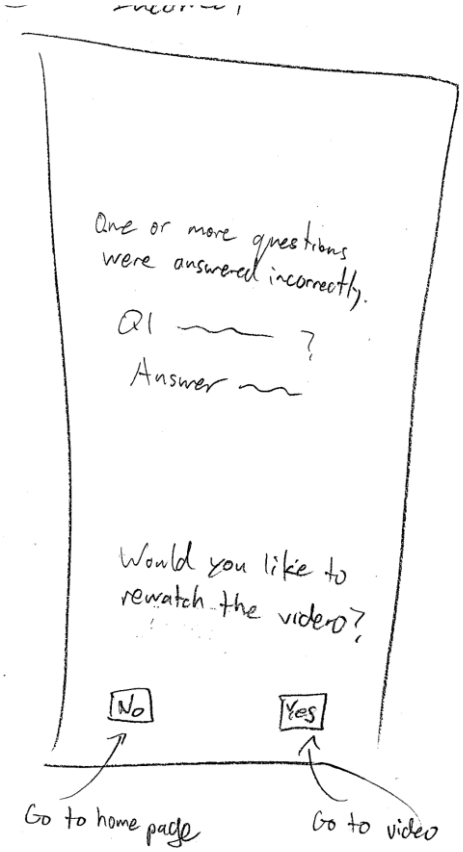

Figure C24: The review screen for the methods.

APPENDIX D

Prototype 3

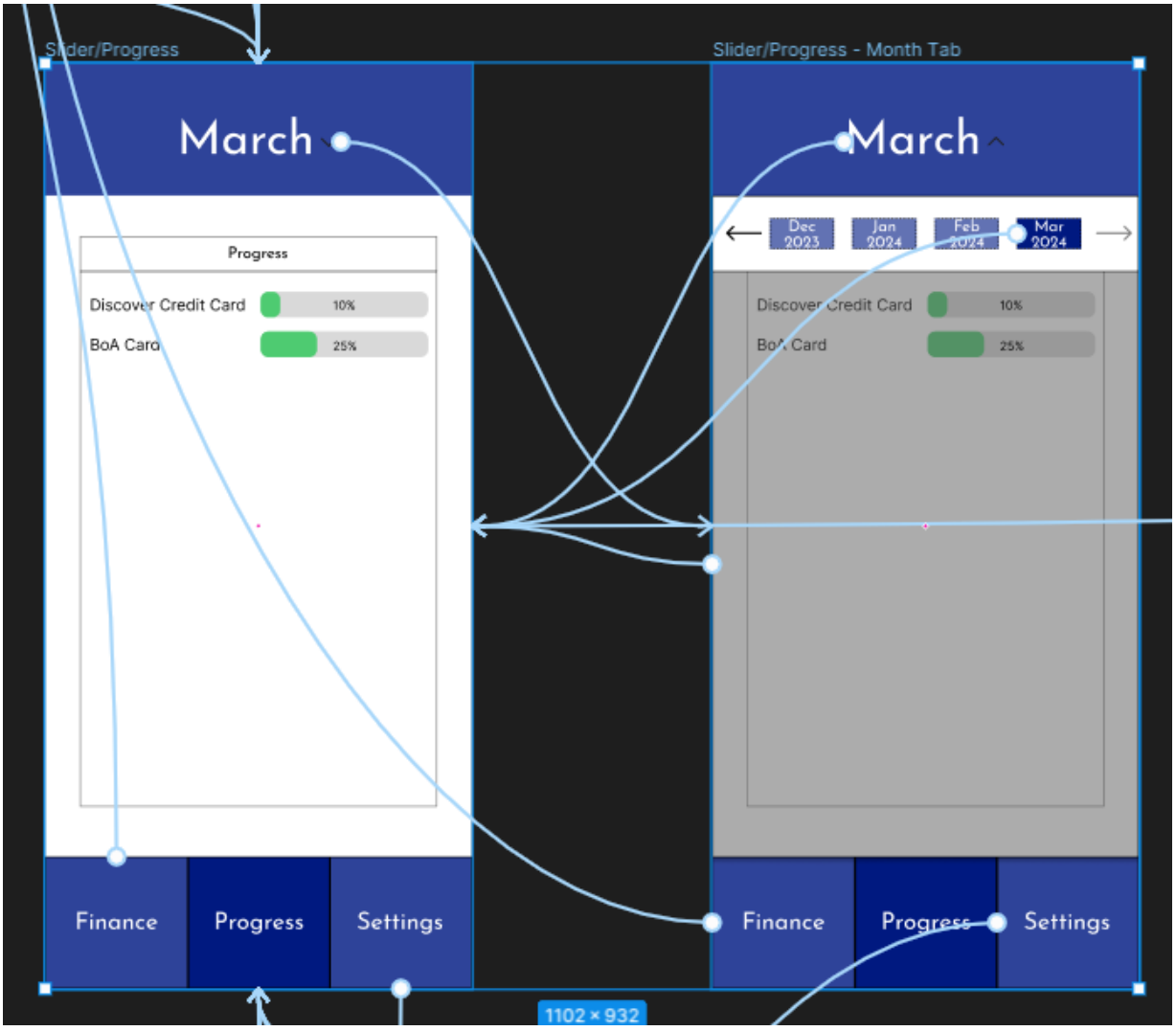

Figure D1: The new progress bars with percentages and the month selector.

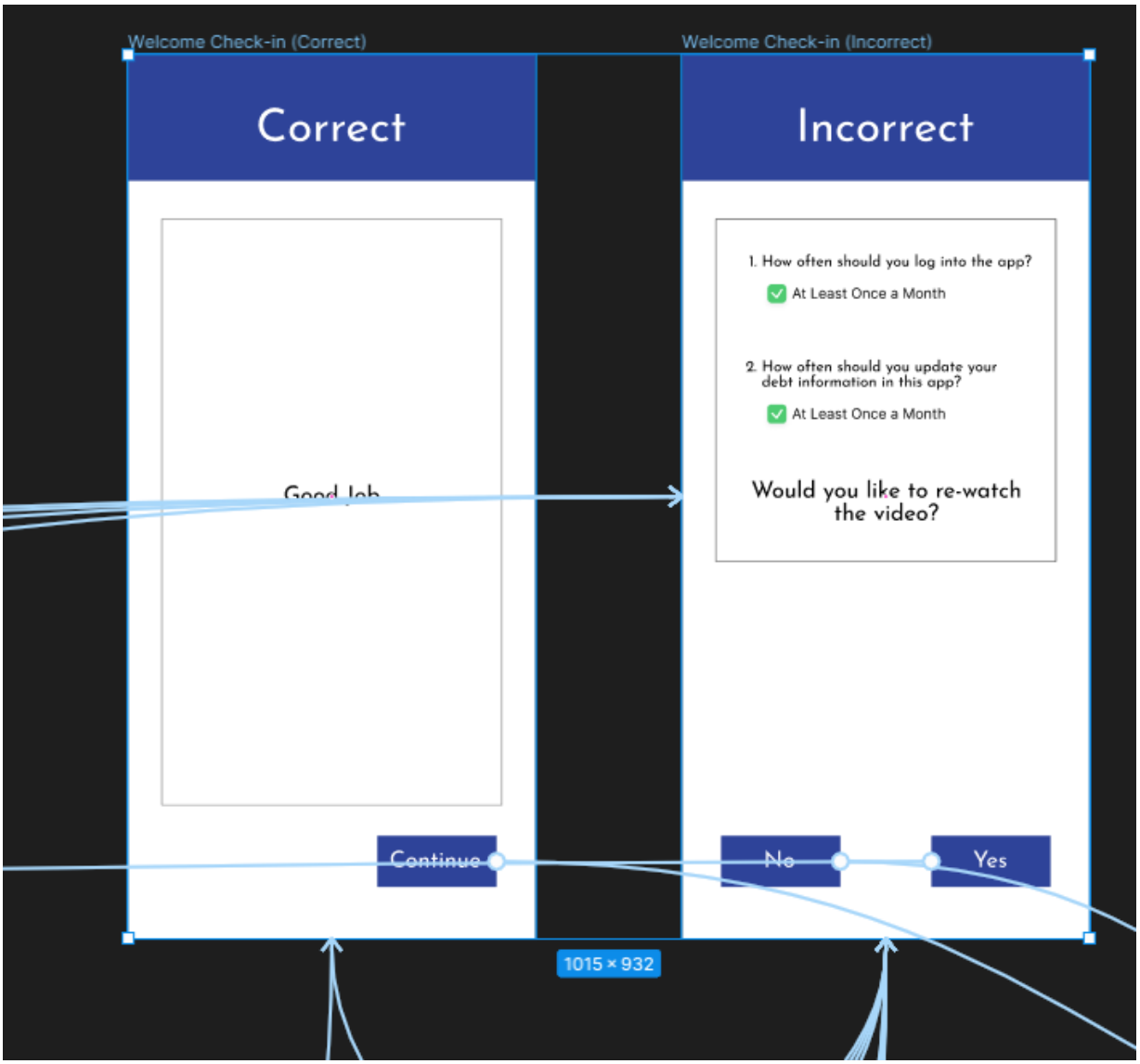

Figure D2: The fixed correct/incorrect screens following the understanding check for the introduction video.

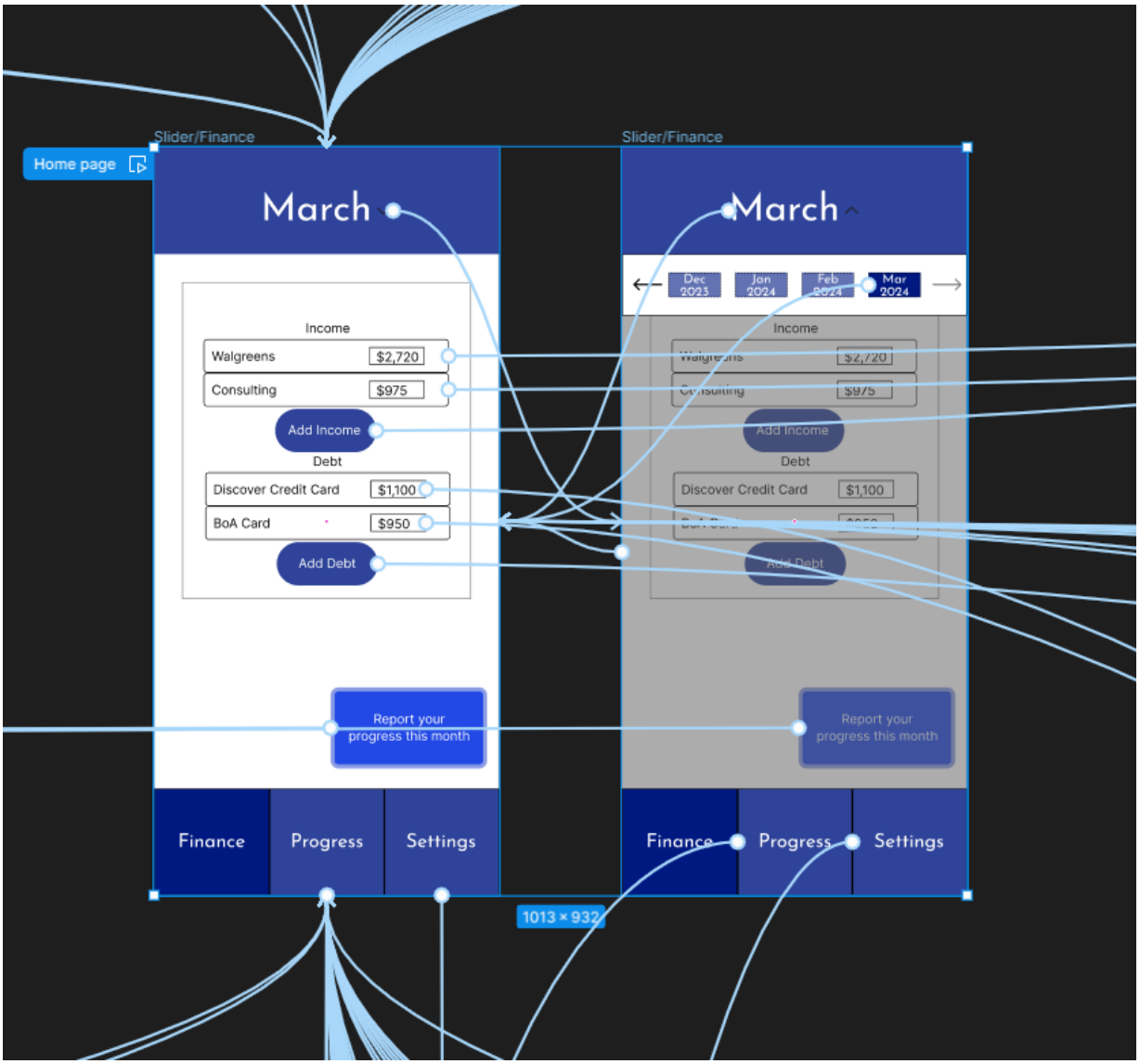

Figure D3: The month selector on the financial information screen

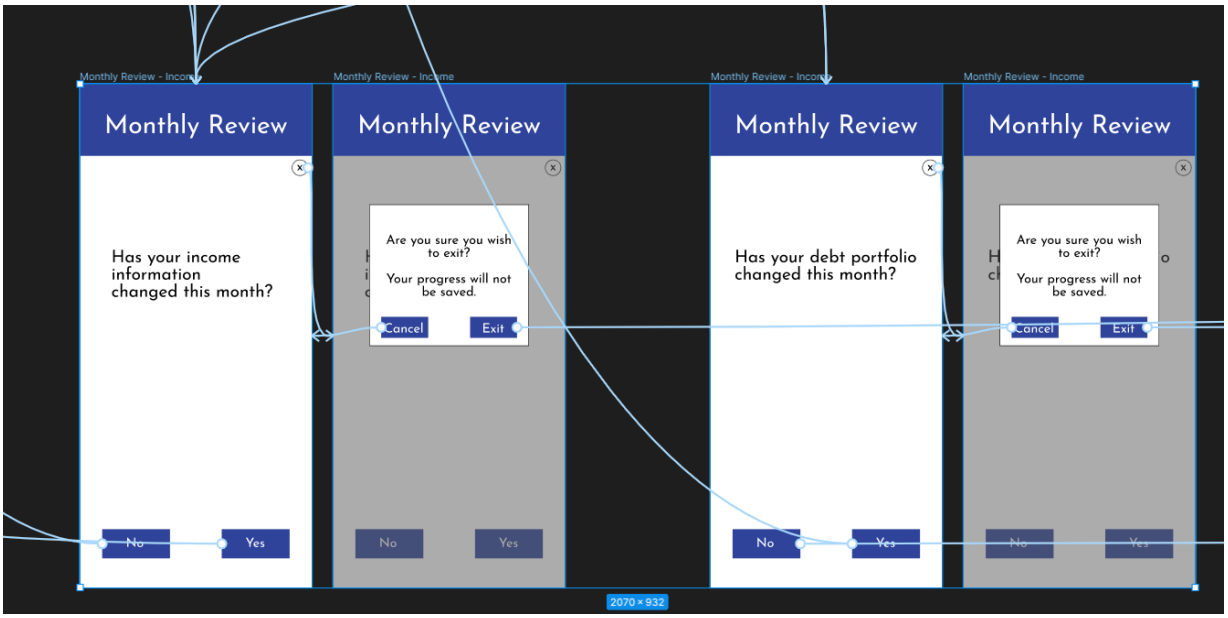

Figure D4: The new exit button for the monthly review.

APPENDIX E

Prototype 4

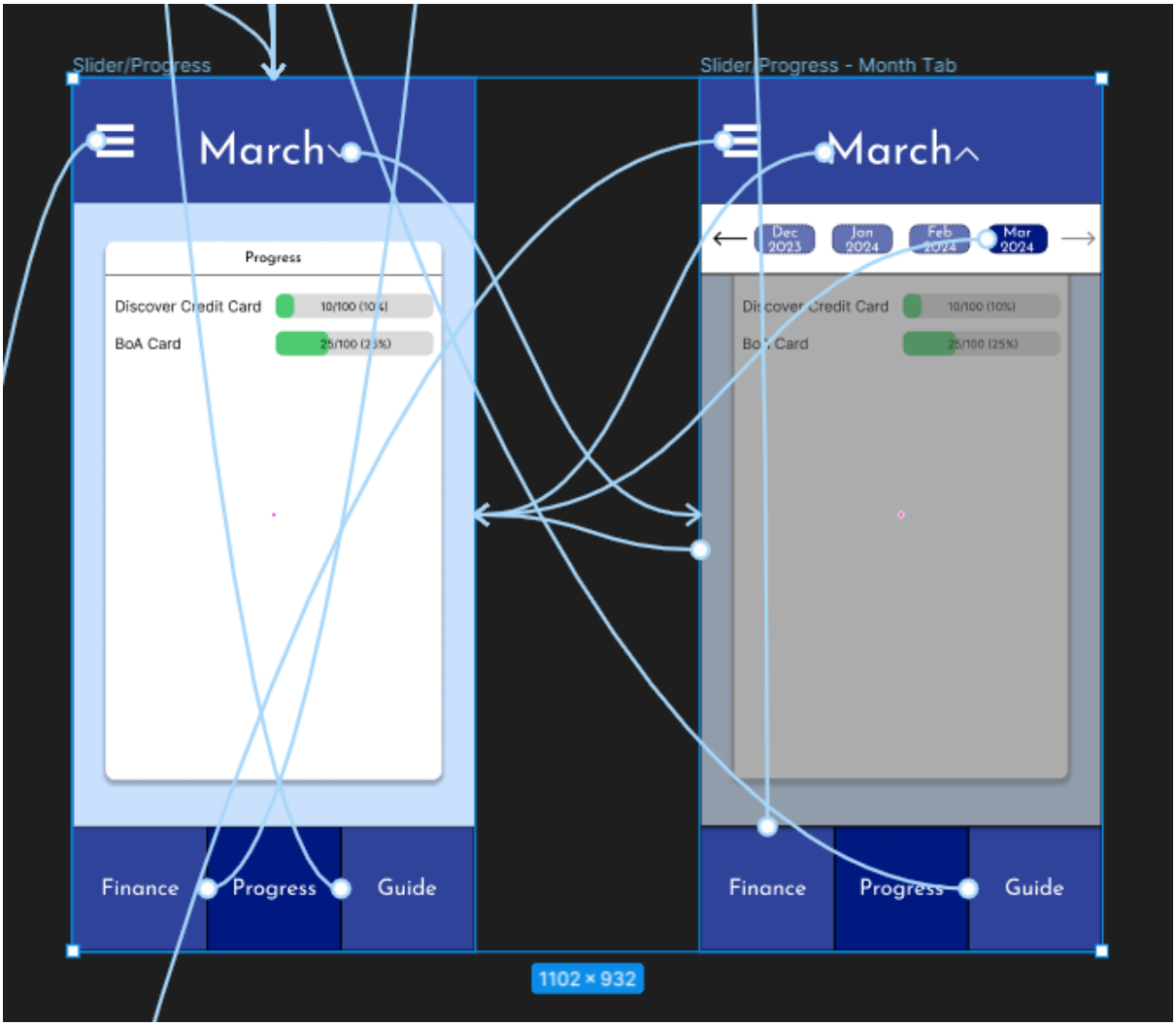

Figure E1: The progress page, now with amounts displayed and the hamburger menu.

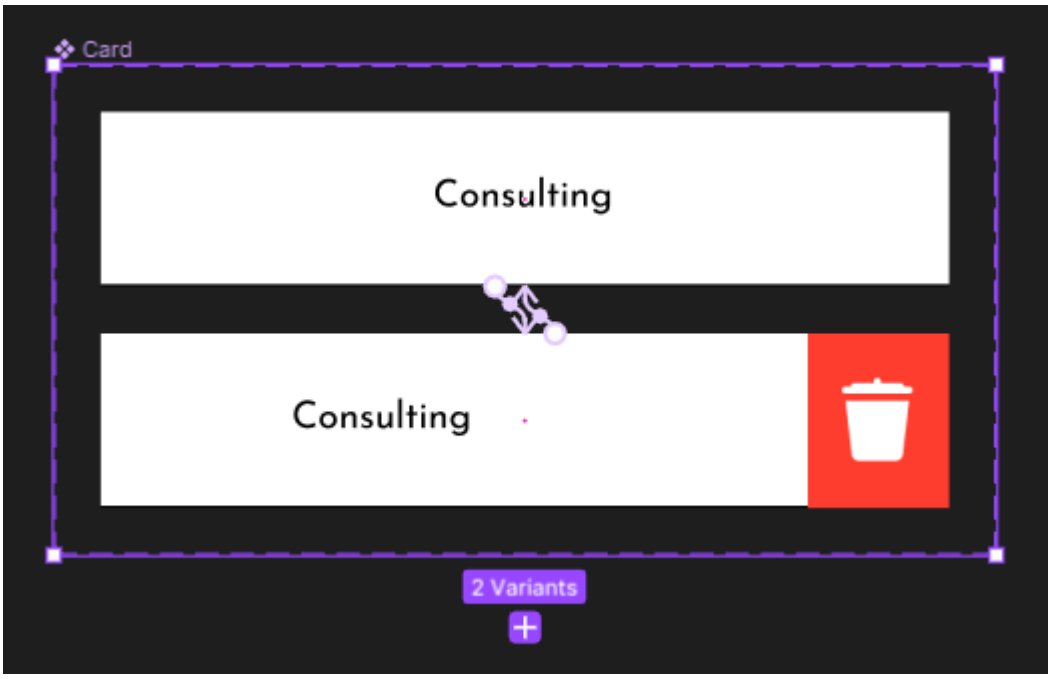

Figure E2: The option to delete an income entry is revealed by swiping left.

Figure E3: The add income page, with a few new flows to fix the dropdown

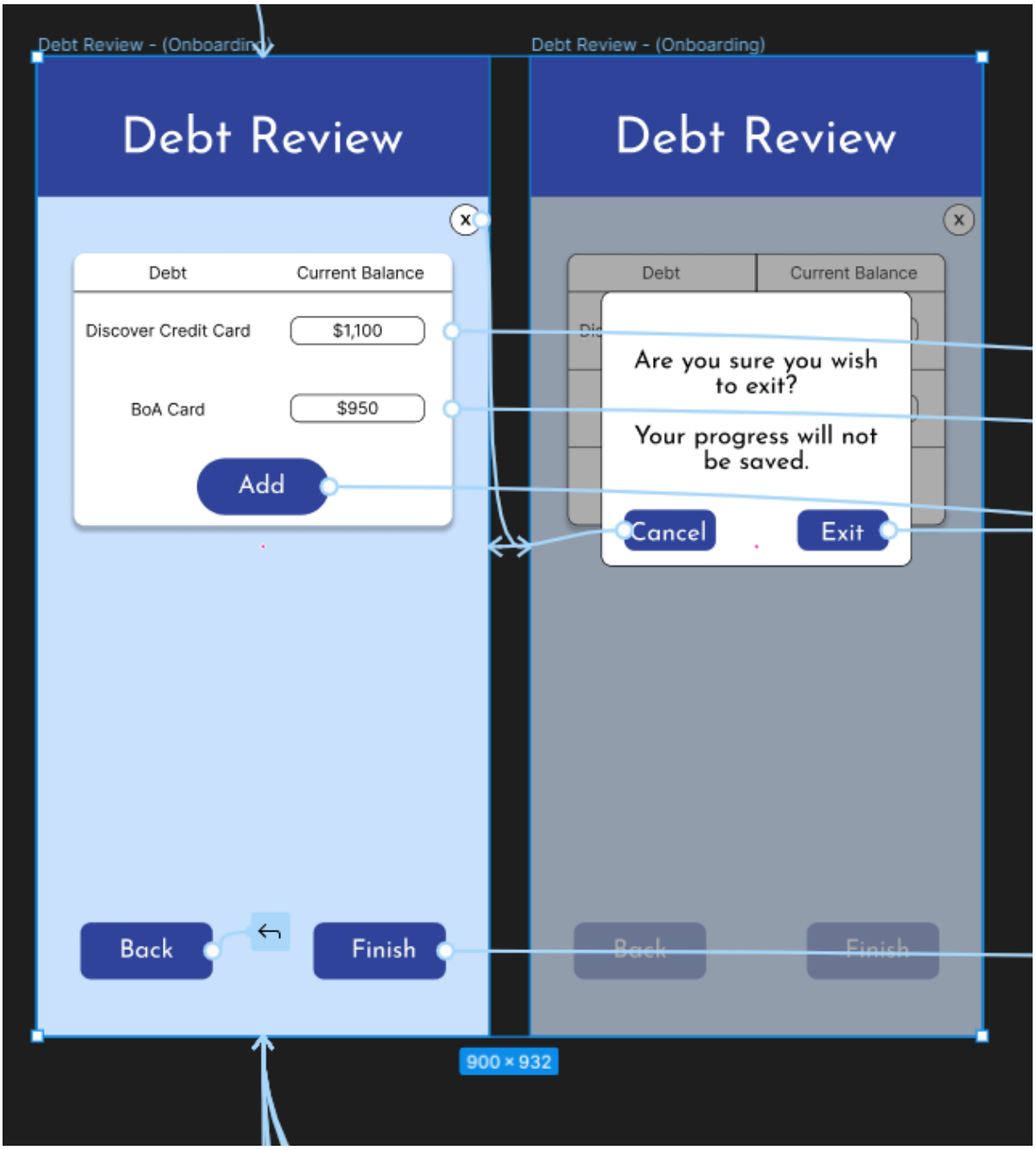

Figure E4: The condensed debt review.

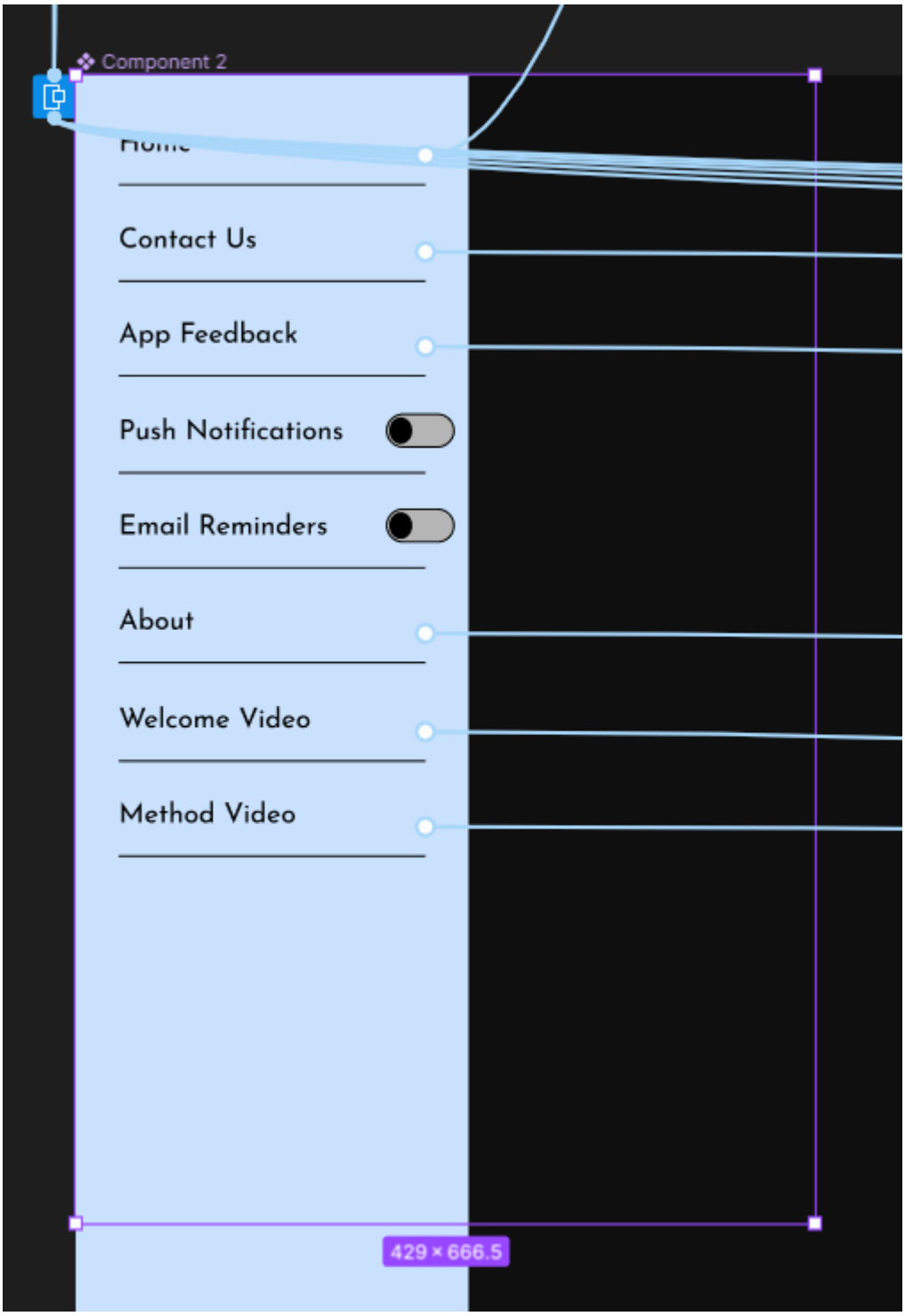

Figure E5: The hamburger menu.

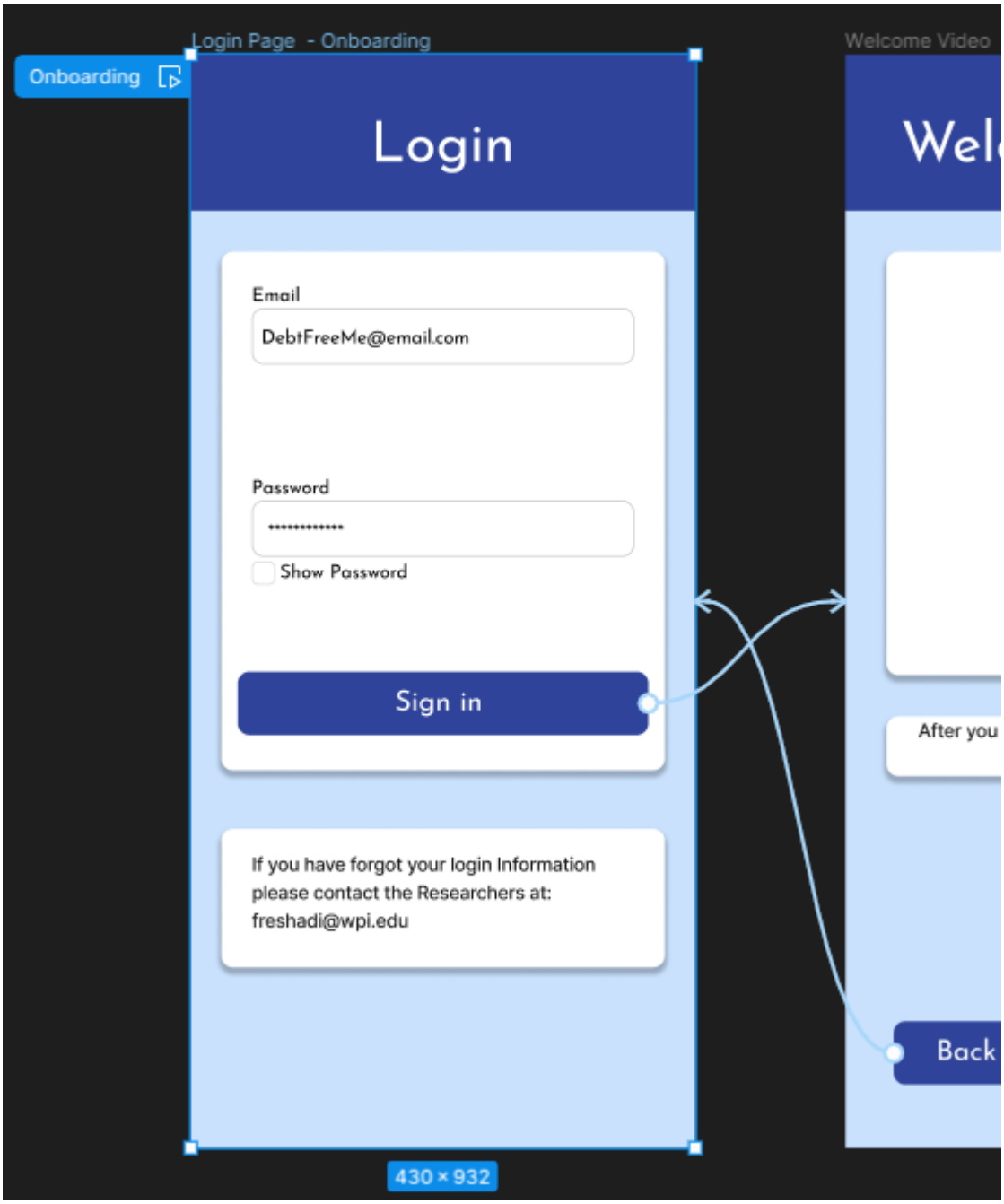

Figure E6: The login screen, now with an option to see the password.

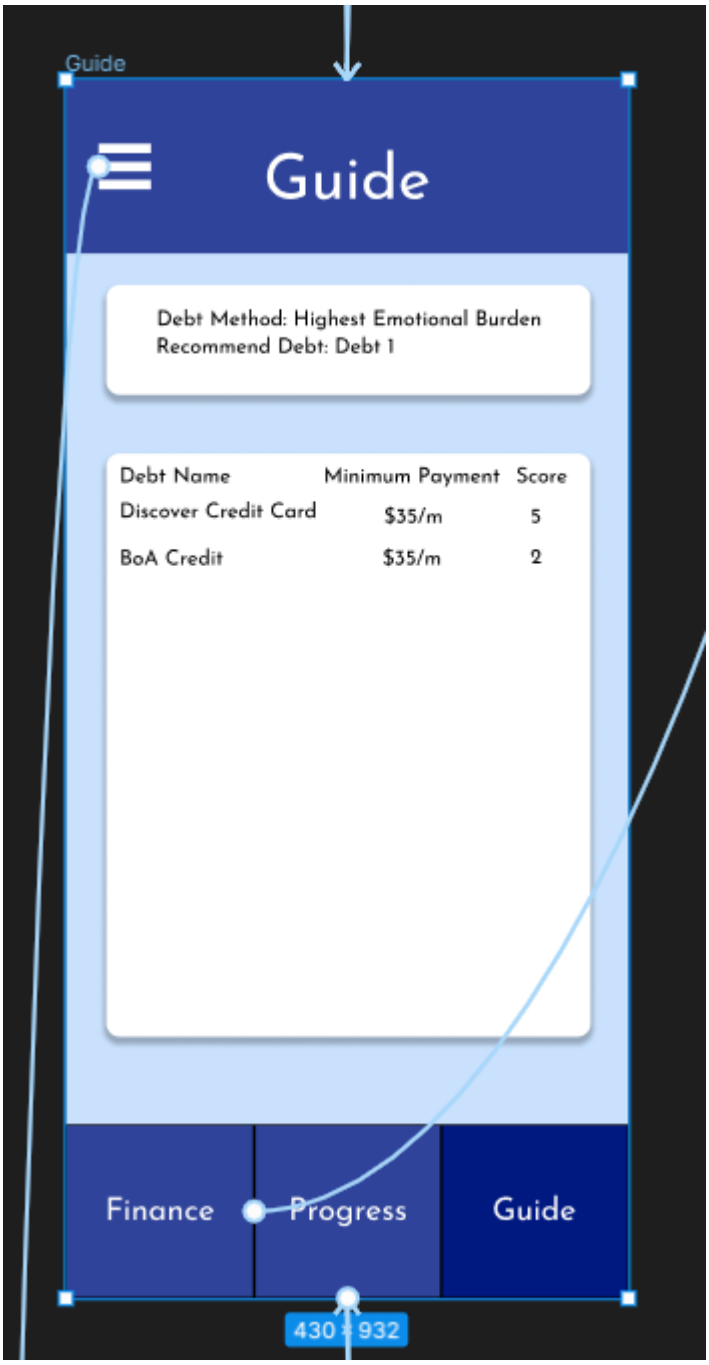

Figure E7: The new guide page.

APPENDIX F

Prototype 5

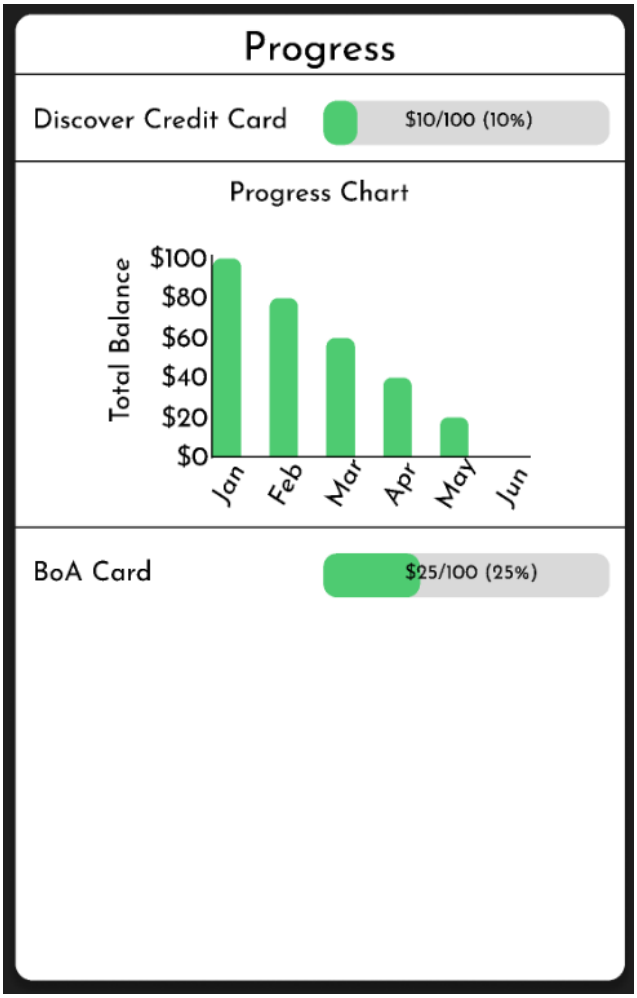

Figure F1: The new bar chart.

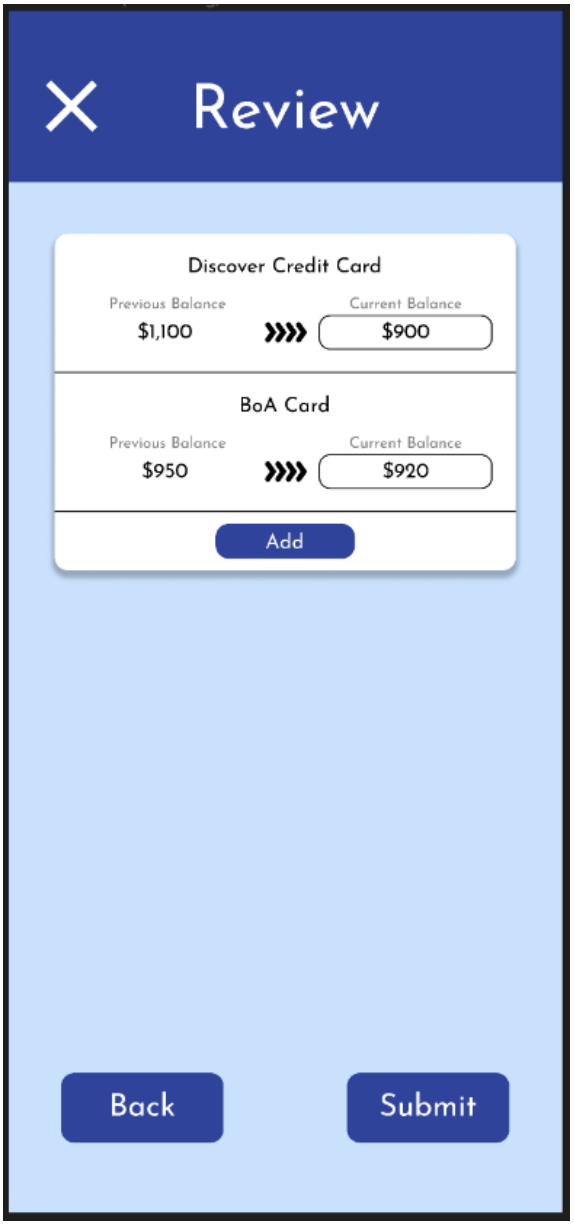

Figure F2: The new format of the debt review.

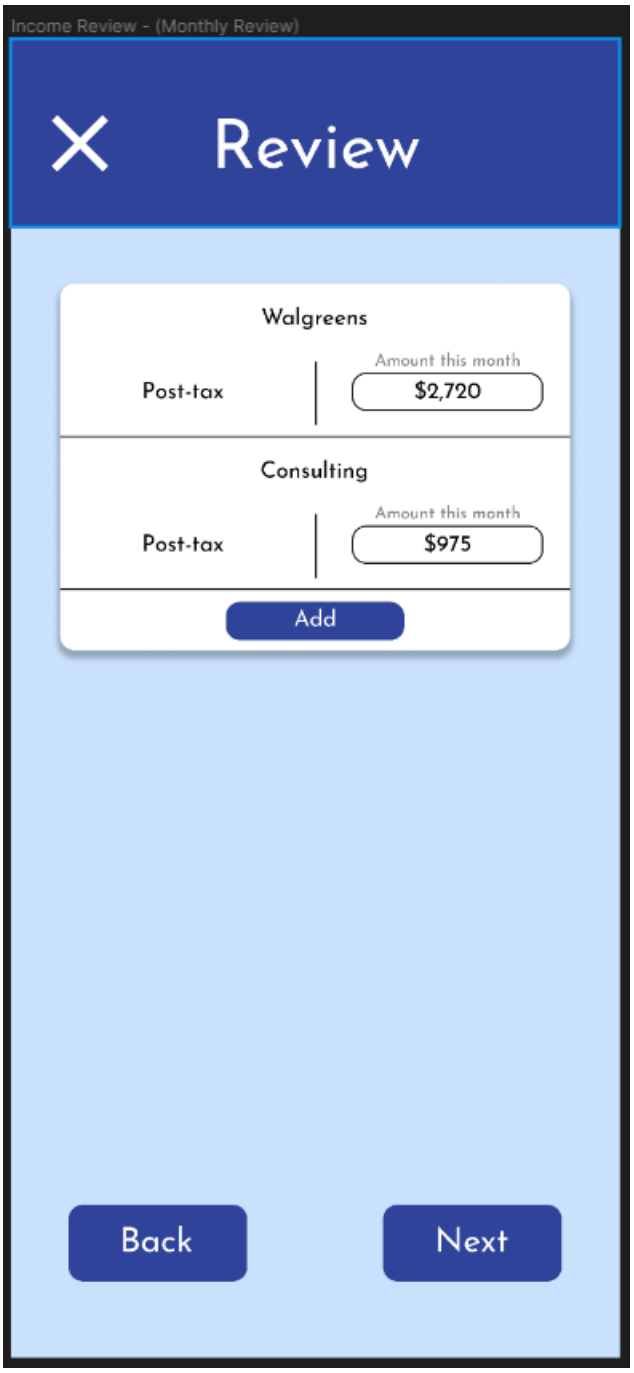

Figure F3: The condensed income review page, styled to match the debt review.

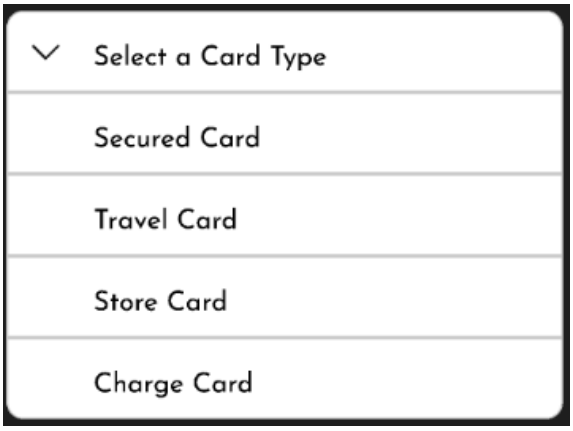

Figure F4: The dropdown selector with the new credit card type options

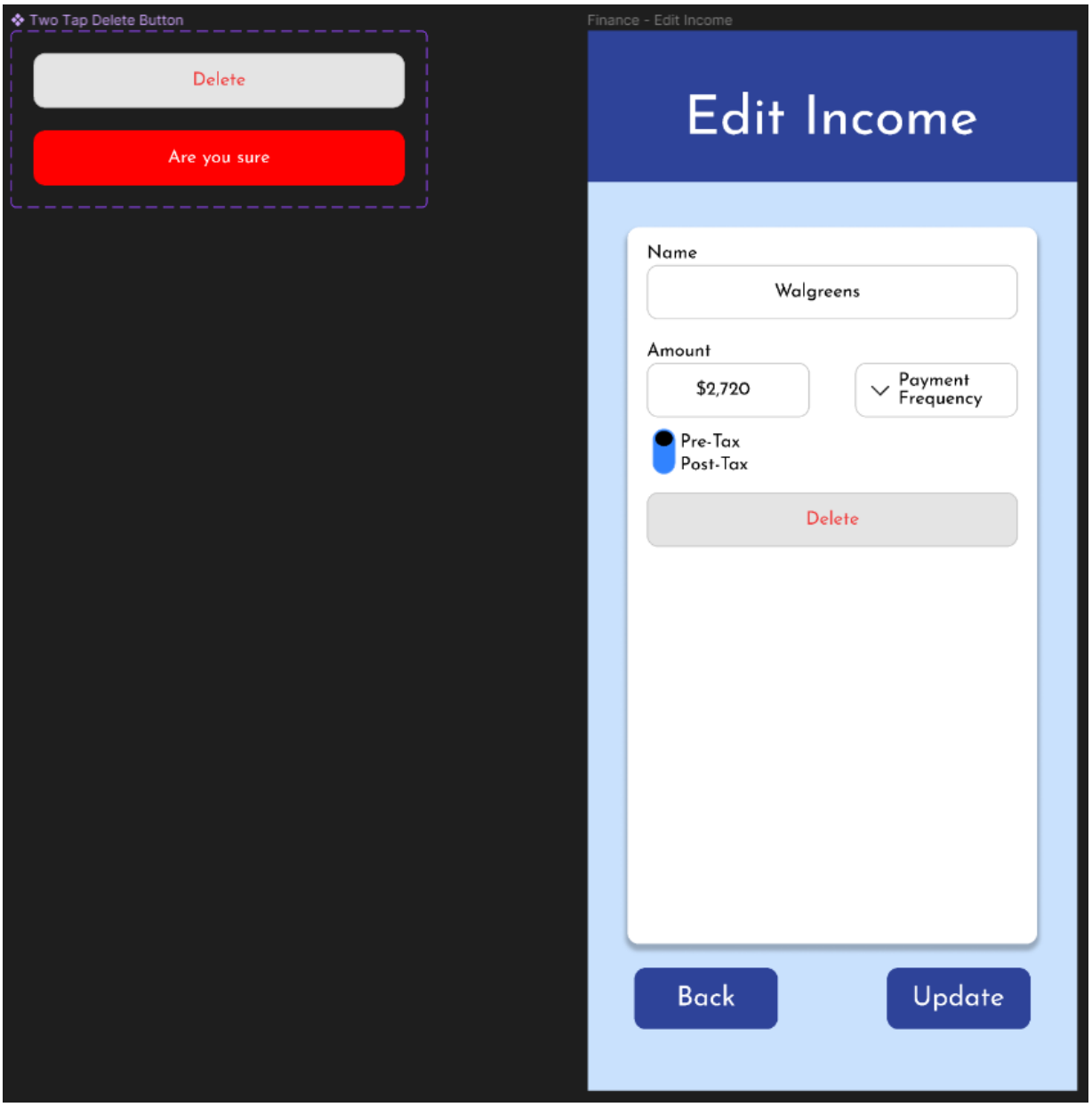

Figure F5: The income editor, with the alternate states of the delete button displayed on the left.

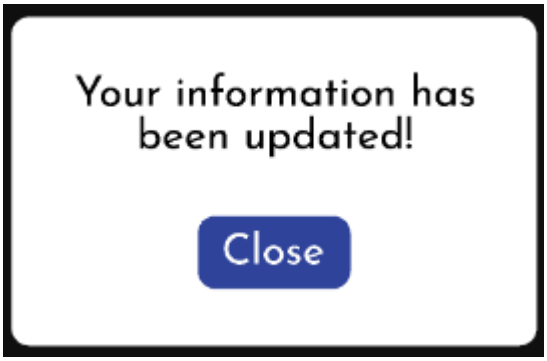

Figure F6: The popup shown upon completion of the monthly review.

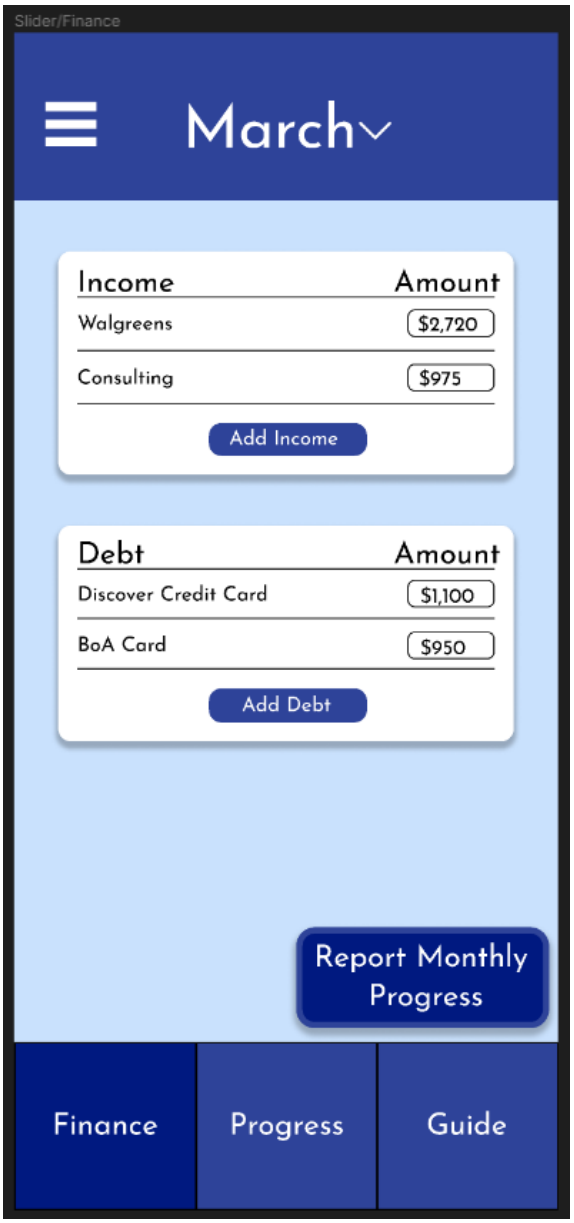

Figure F7: The dual-card configuration of the financial information screen.