



# Rich Embedded Finance Solutions for Colleges and Students

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# Abstract

As the Fintech industry seeks to democratize finance for consumers and businesses, higher education lacks streamlined financing options. Through embedded finance, merging financial services into broad applications, our team created a mock WPI tuition portal for Citizens Bank. This solution will forge fresh lending ties with WPI students and fortify existing ones. Powered by React-based Next.js and Prisma, an in-memory database ORM, the application mimicked accessing student tuition and bank data. It offered an interface embedding financial services and lending details. The team deployed the product onto Citizens Bank's CI/CD pipeline, aligning practices closely with the company's standards. This framework is a model for implementing embedded finance within college environments.

# Acknowledgments

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# Executive Summary

Collaborating with the Frontier Pod, an internal team within Citizens Bank comprising five software engineers and a Product Owner operating within the External Integration Strategy division, a financial portal was created. The implementation of the portal enables WPI students to streamline the process of applying for loans and making payments. In creating the portal, the WPI team leveraged various technical platforms such as BitBucket for source code management, Jenkins for automation and deployment, OpenShift for deployment, Docker for containerized package delivery, Postman for HTTP request testing, and Jest for unit testing. This project is designed for external use for WPI students and the financial aid office, as it will improve the current process WPI employs when making financial payments. By displaying student tuition and financial aid information within the same portal, integrated with Citizens Bank accounts and financial services, this prototype streamlines the payment process, and provides value to students, Citizens Bank, and WPI. The student's value proposition lies in expediting tuition payments, enhancing comprehension of loan repayments, and promptly accessing tuition statements. Colleges like WPI stand to benefit from increased punctuality in payments and fostering partnerships with financial institutions. Nevertheless, the primary value proposition lies in the advantages accruing to the bank. Establishing fresh connections between the WPI community and Citizens Bank has the aims to secure enduring borrowing opportunities at the institution while further fortifying ties with current customers.

Fintech optimizes the way people and businesses access, manage, gain insight into their finances, and make financial transactions. The fintech industry is used to innovate and improve financial services. While many different variations of fintech exist today, much of the market relies on electronic payment systems to keep commerce alive (Anoriega, 2022). Embedded

finance is the practice of including seamless financial transactions within an application to simplify the experience of accessing financial services. While companies like Plaid, Stripe, and others deal with the logistics of making embedded finance possible, many other fintech companies integrate the operations that these companies provide, benefiting both businesses (Sullivan, 2022). Typically, the service that contains the embedded component is not a financial platform or related to one. Instead, online marketplaces, ride-sharing applications, and many other services are prime clients for embedded finance to improve their capabilities and services.

Team Scholar, the WPI team composed of one business student and two computer science students, effectively leveraged a suite of applications and software tools to create user interfaces/portals, enforced adherence to UI standards, and carefully considered the application's look and feel. Notably, Visual Studio Code (VSCode) was the integrated development environment (IDE) of choice for efficient coding and collaboration. BitBucket was the primary platform for efficient source code management and Jenkins served as the automation server for seamless deployment. Additionally, the team received assistance from the DevOps team who configured services in OpenShift and Docker to host the deployed application. These software tools were instrumental in handling deployment processes and played a vital role in containerizing the application. The team used Postman to send HTTP requests. Throughout the project, the team gained first-hand experience in what it was like to work within the confines of a heavily regulated and highly respected financial institution. By collaborating with senior software engineers and contributing production-level code, the team gained insights into the industry's strict standards and the importance of precision and compliance. The team also became part of the bank's daily routine, followed the same schedule, attended company meetings/ceremonies, and fully embraced Citizens Bank's work culture. This deep integration

helped us understand the bank's inner workings, collaborate closely with the bank's employees, and align our work with the bank's mission. It was a valuable experience that went beyond just technical skills.

# Table of Contents

Abstract	ii
Acknowledgments	iii
Executive Summary	iv
List of Figures	x
List of Tables	xi
Authorship	xii
1. Introduction	1
1.1 Problem Statement	2
1.2 Goals	3
2. Background	4
2.1 Citizens Bank	4
2.2 Fintech and Embedded Finance	6
2.2.1 Embedded Finance Solutions	6
2.2.2 Embedded Investing	7
2.2.3 Embedded Lending	7
2.2.4 Embedded Insurance	8
2.3 Embedded Finance and College	9
3. Methodology	10
3.1 Agile Project Management	10
3.1.1 Agile Framework	11
3.1.2 Scrum Team Roles	11
3.1.3 Scrum Meetings	13
4. Citizens Bank Development Environment	15
4.1 Development Environment	15
4.1.1 BitBucket	15
4.1.2 VSCode (Integrated Development Environment)	16
4.1.3 Postman	16
4.1.4 Jest Unit Testing	17
4.2 CI/CD Pipeline	18
4.2.1 Jenkins	18
4.2.2 Docker	18
4.2.3 OpenShift	19
	vii

4.3 Authorization and Security	19
5. Software Requirements and Design	20
5.1 Software Requirements Gathering	20
5.1.1 Use Cases	21
5.1.2 FDX Specification	22
5.1.3 User Stories and Epics	25
5.2 Design	27
5.2.1 Functional and Non-functional Requirements	27
5.2.2 System Architecture	28
5.2.3 Database Schematics	29
6. Software Development	31
6.1 Sprint 0	32
6.1.1 Sprint 0 Retrospective	36
6.2 Sprint 1	38
6.2.1 Sprint 1 Retrospective	39
6.3 Sprint 2	41
6.3.1 Sprint 2 Retrospective	44
6.4 Sprint 3	46
6.4.1 Sprint 3 Retrospective	47
6.5 Sprint 4	48
6.5.1 Sprint 4 Retrospective	50
6.6 Sprint 5	51
6.6.1 Sprint 5 Retrospective	53
6.7 Sprint 6	55
6.7.1 Sprint 6 Retrospective	56
7. Business and Project Risk Management	57
7.1 Risk Mitigation	57
7.2 Compliance Risk	58
7.3 Operational Risk	58
7.4 Strategic Risk	59
7.5 Technology Risk	59
7.6 Financial Crime	59
7.7 Reputational Risk	60
8. Assessment and Retrospective	61



8.1 Team Learnings	61
8.1.1 Andrei’s Learnings	61
8.1.2 Nikola’s Learnings	62
8.1.3 Zach’s Learnings	64
8.2 Business Learnings	65
8.2.1 Citizens Bank Culture	65
8.2.2 Citizens Bank Leadership	66
8.3 Technical Learnings	66
8.3.1 Balancing Stability and Functionality	66
8.3.2 Deploy First, Code Later	67
8.3.3 Operational Adaptation in a Corporate Environment	69
9. Future Work	70
9.1 Embedded Finance for Colleges	70
9.2 Financial Visualization	70
10. Conclusion	72
References	74
Appendix	77
A. Interface Screenshots	77

# List of Figures

Figure 1: Diagram of Agile Project Plan Methodology	10
Figure 2: Weekly Sprint Process Flow	13
Figure 3: Redhat CI/CD Pipeline	18
Figure 4: Use Case Diagram	21
Figure 5: Tuition Portal System Architecture	28
Figure 6: Initial Database Schematic	30
Figure 7: Application Database Schematic	30
Figure 8: Initial Interface Design	37
Figure 9: Sprint 1 Burndown Chart	38
Figure 10: Financial Dashboard Login Screen	40
Figure 11: Financial Dashboard Homepage	41
Figure 12: Mock Student Account Screen	41
Figure 13: Sprint 2 Burndown Chart	42
Figure 14: Initial Citizens Loan Dashboard	45
Figure 15: Updated Citizens Loan Dashboard	45
Figure 16: Sprint 3 Burndown Chart	46
Figure 17: Sprint 4 Burndown Chart	49
Figure 18: Sprint 5 Burndown Chart	52
Figure 19: Final Dashboard	54
Figure 20: Total Product Burndown Chart	55

# List of Tables

Table 1: User Stories and Epics	27
Table 2: Planned Development Timeline	31
Table 3: Sprint 0 User Stories and Epics	32
Table 4: Undergraduate Student Loan 5-Year Repayment	34
Table 5: Undergraduate student 10-Year Repayment	35
Table 6: Undergraduate Student 15-Year Repayment	35
Table 7: Sprint 1 User Stories and Epics	38
Table 8: Sprint 2 User Stories and Epics	42
Table 9: Sprint 3 User Stories and Epics	46
Table 10: Sprint 4 User Stories and Epics	48
Table 11: Sprint 5 User Stories and Epics	52
Table 12: Sprint 6 User Stories and Epics	55

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Citizens Development Environment	NG, AB	AB
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# 1. Introduction

As a company interested in advancements in fintech, Citizens Bank works towards implementing embedded financial capabilities to better provide services to colleges and their students. Worcester Polytechnic Institute's financial portal, like many college tuition portals, often requires a student to navigate between multiple sites to pay their tuition, view financial aid awards, and explore loan options. The prototype portal accomplished this by containing all necessary financial needs, thus being a simpler and more convenient solution to the current fragmented dashboard offered. This effort aimed to show how to improve college students' user experiences when making financial decisions. Additionally, the benefit of this project to Citizens Bank is the opportunity to forge fresh ties with Citizens Bank, with the goal of securing extended borrowing options at the institution, while concurrently fostering and reinforcing relationships with current customers.

Throughout the seven-week project, the team worked to create a fully functioning prototype that displayed student tuition and financial aid information. The dashboard had an integrated Citizens Bank login. By logging in with a Citizens account, the user can finance or pay tuition. Different loan options were displayed based on the student's credit scores, allowing them to choose a loan that best suits them. The team recognized that students are new to financing and loans, therefore providing clear and concise information is necessary.

Team Scholar, the group of three WPI students acted as a sub pod of Team Frontier, the External Integration business unit at Citizens Bank. The WPI team worked and attended full-time employee ceremonies in conjunction with Team Frontier. This allowed the team to gain valuable experience in a highly regulated industry. In-person meetings and interactions led to the team

developing more profound relationships with the Citizens Bank team and experiencing corporate culture.

## 1.1 Problem Statement

”How might we create an integrated and user-friendly embedded finance solution that simplifies and optimizes financial management for college students, offering them convenient access to essential financial services and resources throughout their academic journey?”

—Jeff Collemer

Students are tasked with managing various expenses throughout college, namely tuition payments, and potential student loans. The fragmentation of these elements across multiple portals is a major pain point in the infrastructure of college finance. The student needs to handle tuition payments every semester, manage loans and financial aid awards, and navigate through different portals for each of these tasks. Although most of the information is accessible through the student's account, managing multiple bank and university accounts separately can be overwhelming. The process of accessing each account individually while trying to make sound financial decisions can become burdensome for the student, on top of academic pressure. Providing students with a solution to managing college expenses will improve their college experiences, introduce them to personal finance, and allow them to quickly develop a relationship with a bank as they enter higher education.

## 1.2 Goals

The team set out to create a dashboard that merges Citizens' banking functionalities into WPI's student portal. The application serves as the single location for student financial needs (student loans, current balances, interest rates & repayment options). By addressing this pain point, the team hopes to show that integrating embedded finance into tuition payments enhances the experience of college students and incentivizes them to form a long-lasting relationship with their providing bank.

## 2. Background

### 2.1 Citizens Bank

Originally established in 1828 in Providence, RI, as the High Street Bank, it was not until 1871 that the Rhode Island legislature gave a charter to establish Citizens Savings Bank, which eventually formed Citizens Trust Company (Zippia, 2023). It was acquired by the Royal Bank of Scotland Group as a holding in 1988, which then allowed the bank to acquire more branches in New England and become the second-largest bank in the region (DiGeronimo, 2004). In 1999, the bank acquired the United States Trust Company of Boston, creating a greater presence in Massachusetts and Boston. Expansion to other states took off when Citizens acquired Cleveland-based Charter One Financial in 2004. Charter One, the parent company of Charter One Bank, had branches in Illinois, Ohio, Indiana, Michigan, New York, and Vermont at the time of acquisition. This transaction made Citizens one of the largest bank holding companies in the country, as Charter One Financial had \$41 billion in assets and branches in nine states and included \$10.5 billion in cash (DiGeronimo, 2004). In 2013, the Royal Bank of Scotland issued an initial public offering for Citizens after pressure in the United Kingdom to sell foreign assets. After the bank began selling on the New York Stock Exchange in 2014, RBS sold its remaining shares in 2015 (Zippia, 2023). A year later, Citizens joined the Fortune 500.

Citizens Bank operates primarily within the corporate finance and commercial banking sectors and is dedicated to prioritizing the interests of its customers, colleagues, communities, and shareholders (*About Our Company*, n.d.). It operates business through two operating segments: consumer banking and commercial banking. The first segment, consumer banking, “Serves retail customers and small businesses with annual revenues of up to \$25 million” (*Our*



*Business*, n.d.). Its products and services include deposit products, mortgages, home equity lending, student loans, auto financing, credit cards, business loans, and wealth management and investment services. The next operating segment, commercial banking, “targets companies and institutions with annual revenues of \$25 million to \$2.5 billion” (*Our Business*, n.d.). This segment offers broad financial products and solutions, including lending and leasing, trade financing, deposit and treasury management, foreign exchange and interest risk management, corporate finance, and debt and equity capital market capabilities. Citizens has positioned itself as a major player in consumer and commercial banking with 3,400 ATMs and 1,100 branches across 14 states in the New England, Mid-Atlantic, and Midwest regions with its integrated mobile and online banking solutions (*Our Business*, n.d.).

The digital transformation, which is the race to integrate fintech capabilities into business operations has impacted numerous sectors, compelling companies to either adapt or face closure. This is evident in the highly regulated financial industry with the rise of fintech companies. Many view these companies as disruptors; however, Citizens Bank has fully embraced digital technology, mobile and online banking, and innovation. As customers seek ease of access and speed, “Citizens was the first large regional bank to offer a fully integrated digital banking and wealth advisory offering. We see this service, called SpeciFi, as a great platform that makes investing more accessible to a larger set of customers” (Young, n.d.). Additionally, Citizens’ is a founding partner of the MassChallenge Fintech program, which accelerates innovation in the financial services industry by making it easier for startups and established businesses, institutions, and organizations to work together (MassChallenge, 2023).

## 2.2 Fintech and Embedded Finance

The rise of fintech, short for financial technology, has significantly reshaped the financial industry over the past decade. Fintech companies leverage cutting-edge technology to provide innovative financial solutions, disrupt traditional banking models, and enhance the overall customer experience (Jacobson, 2023). One of the most impactful evolutions within the fintech ecosystem is the emergence of embedded finance.

Embedded finance represents a natural progression within the fintech space. It refers to the seamless integration of financial services into a traditionally non-financial platform. In-app payments, peer-to-peer lending, and microinsurance are all examples of embedded finance being utilized (Jacobson, 2023). Whether you are placing an order for food on your mobile device, requesting a ride via a ridesharing app, or making a transaction using a mobile payment service, you are actively engaging with embedded finance technologies. This integration unlocks a world of financial possibilities for consumers, blurring the lines between financial institutions and everyday services. Embedded finance uses the power of technology to bring financial services closer to the user, making them an integral part of their daily interactions.

### 2.2.1 Embedded Finance Solutions

As embedded finance continues to reshape the financial industry, it is essential to understand its various dimensions, each tailored to meet specific financial needs and preferences. One of its prominent facets is embedded payments, where technology giants like Amazon, Uber, DoorDash, and Instacart have perfected the art of integrated payments, letting customers place an order and pay for it all in one application. Google Pay, Apple Pay, and Venmo are other examples of embedded payment applications where users can store financial information and

conduct transactions in one place (Jacobson, 2023). This innovation has redefined convenience, making transactions smoother and more secure. With embedded payments, personal financial information does not need to be shared with third parties, ensuring user data privacy while providing a quick and easy checkout experience.

### 2.2.2 Embedded Investing

Embedded investing represents another pivotal dimension of embedded finance. This innovation has significantly reshaped the investment industry, making it more accessible and user-friendly than ever before. Prominent companies such as Robinhood, Acorns, and Cash App, which incorporate stock market investing into their platforms, all serve as instances of embedded investment enterprises (Author, 2023). Purchasing, selling, and trading stocks can all take place within the app, eliminating the need to exit the platform. This high level of integration offers a convenient and efficient way of engaging with financial markets, eliminating the need for third-party brokerage platforms or investment advisors. These applications have made it possible for nearly anyone with a smartphone to participate in financial markets. Their user-friendly interfaces and streamlined investment processes have democratized access to stocks, bonds, ETFs, and other securities. As the embedded finance landscape continues to evolve, the profound impact of embedded investing continues to transform financial services, empowering individuals, and businesses to navigate the difficulties of the modern financial world with ease and accessibility.

### 2.2.3 Embedded Lending

Much like how embedded investing has revolutionized access to financial markets, embedded lending is colossal in the world of Embedded Finance. It is altering the way

individuals and businesses handle their finances. Embedded lending allows users to buy now and pay later through structured installment plans, integrated into various platforms. For instance, popular shopping apps like Afterpay and Klarna have embraced embedded lending, enabling consumers to split their purchases into manageable installments (Brown, n.d.). This approach makes it easier for people to afford essential products and services by spreading payments over time. It simplifies the buying process and contributes significantly to the evolving landscape of Embedded Finance, providing users with more flexibility and convenience to manage their financial matters. These apps, along with others in the Embedded Finance space, empower individuals to make informed financial decisions while enjoying greater control over their budgets.

#### 2.2.4 Embedded Insurance

As the final type of embedded finance, embedded insurance stands out as a transformative force within this ever-evolving landscape. It simplifies the insurance process, cutting out the hassle of traditional interactions with insurance agents. For instance, when booking a flight for your next trip or buying a new car, you can simply add insurance coverage during the checkout process, making it a breeze to secure the protection you need right when it matters most (Stice, 2023). This seamless integration not only boosts convenience but also puts the power of insurance decisions right at your fingertips. In the dynamic world of embedded finance, embedded insurance showcases how technology is revolutionizing the way our assets and well-being are safeguarded.

The emergence of the various types of embedded finance within the fintech landscape signifies a fundamental shift in the interaction with financial services. This has effectively integrated financial offerings into our daily experiences, enhancing convenience, accessibility,

and control over our financial matters. Whether making in-app payments, investing in stocks through user-friendly platforms, utilizing embedded lending options, or securing insurance coverage effortlessly, Embedded Finance showcases the power of technology to redefine the financial industry. Looking ahead, the evolution of embedded finance promises to continue bridging the gap between traditional financial institutions and the services customers rely on, ultimately empowering individuals and businesses to navigate the modern financial world with unprecedented ease and flexibility.

## 2.3 Embedded Finance and College

College represents a substantial financial decision for students, but often these institutions disregard students' experiences of financing and managing the costs associated with college living. Mobile student IDs enable students to use smartphones, wearables, and other devices to access campus buildings and address everyday college expenses. Existing financial apps for students are common at universities like WPI, regulating services like dining and tuition payments. However, current college students, who are used to using technology with optimized and streamlined user experiences, may become frustrated by the unintegrated and fragmented experience of managing the myriad of college finance obligations (Poynter, 2023).

# 3. Methodology

## 3.1 Agile Project Management

Agile methodology, defined as a project management approach involving the breakdown of projects into phases with a focus on continuous collaboration and improvement, fosters an efficient and coherent development process. Each sprint concludes with discussions aimed at refining the strategy, ensuring a well-polished final product (Dingsøy, 2012). This iterative approach not only accommodates changing requirements but also encourages regular feedback, creating a dynamic and responsive development environment. Agile promotes open communication, transparency, and a shared understanding of project goals among team members, fostering a sense of ownership and accountability. The framework's flexibility enables teams to respond swiftly to evolving project needs, reducing the risk of delays and enhancing overall adaptability. The attached visual below provides a concise overview of Agile's key components, illustrating how its collaborative and iterative nature contributes to the successful delivery of high-quality, customer-centric products.

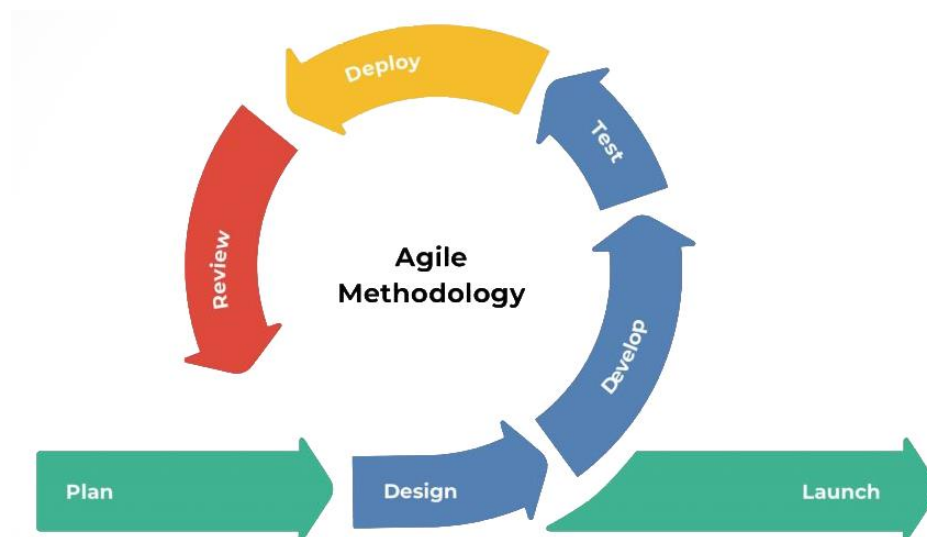


Figure 1: Agile Project Plan (What is Agile methodology)

### 3.1.1 Agile Framework

The foundational elements within the Agile framework encompass concepts like user stories, epics, and the product backlog, which collectively drive the development process. User stories serve as user-centric narratives describing specific features or functionalities, aiming to articulate what is to be done, why it matters, and who it benefits. These narratives are crafted to capture the essence of end-user needs and preferences (Agile Alliance, 2023). In contrast, epics constitute substantial bodies of work, encompassing broader themes or functionalities that require decomposition into more granular and manageable user stories. Meanwhile, the product backlog stands as a comprehensive and prioritized compilation of user stories, epics, bug fixes, and other pertinent tasks that await attention. It serves as a repository for all items slated for future development endeavors, while the sprint backlog holds the specific items designated for a particular sprint, enabling focused and iterative progress. These backlogs serve as dynamic repositories, constantly evolving as the project progresses and as new insights surface, encapsulating a spectrum of functionalities and features necessary for product enhancement and refinement.

### 3.1.2 Scrum Team Roles

Agile methodology revolves around fostering teamwork, efficiency, and collaboration. It achieves this by assigning each team member specific roles tailored to their academic background, experience, and interests (West, n.d.). The team typically comprises a product owner (PO), developers, and a scrum master. This distribution of roles ensures a dynamic and efficient approach, aligning with the foundational principles of Agile for effective project execution.

The product owner, also referred to as the experience owner by Citizens, is responsible for the overall value the product can deliver to the customer. Communication and organization are necessary skills for the product owner, as they must understand the needs of people related to the project, the customer, and business requirements (West, n.d.). Agile project management tools like Jira and Trello are frequently employed by the product owner to effectively manage the sprint backlog, ensuring that all assigned user stories are completed within the stipulated time frame.

The developers play a pivotal role in handling diverse tasks ranging from conceptualization to implementation. These team members are essential to backlog management, actively participating in Scrum meetings and practices, and serving as primary contributors to the successful execution of sprints (West, n.d.). Their versatile involvement underscores their significance in fostering a cohesive and efficient project lifecycle.

The Scrum Master, functioning as a coach to facilitate Scrum practices, looks to serve the team by helping each member deepen their understanding of their role and execute it more effectively over time (West, n.d.). This includes the additional responsibility of running the fifteen-minute daily Scrum meetings.

In the development of complex and constantly evolving projects, Agile provides a flexible approach to the operation of teams. This becomes particularly crucial in scenarios marked by tight schedules, a limited number of developers, and looming deadlines. Agile's strength lies in its ability to accommodate short development cycles, allowing teams to make quick adjustments and continuously improve their processes. This adaptability not only facilitates swift responses to changing project requirements but also ensures the timely



completion of tasks. Beyond these immediate benefits, Agile's iterative approach proves instrumental in addressing evolving customer needs effectively.

### 3.1.3 Scrum Meetings

These meetings serve as key touchpoints within the Scrum framework, facilitating communication, collaboration, and continuous improvement throughout the development process (Scrum Meeting, 2022). Scrum involves several key meetings essential to Agile development. A visual of these meetings and processes is listed below:

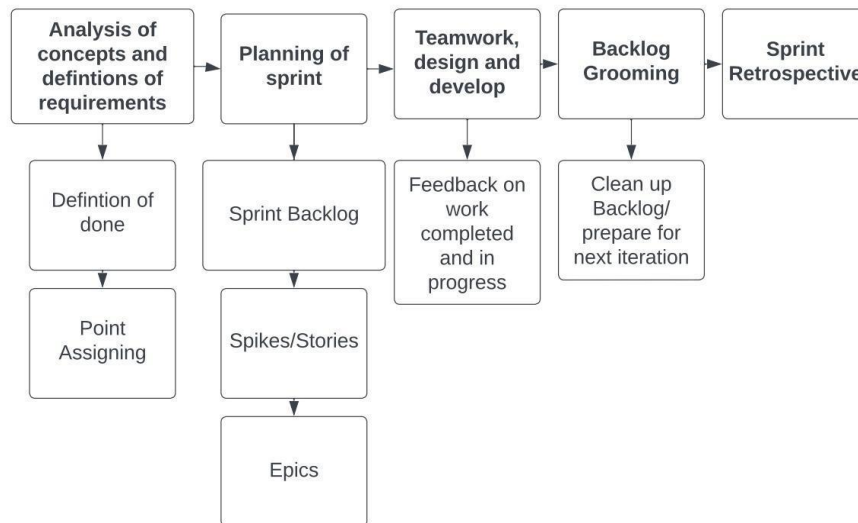


Figure 2: Weekly Sprint Process Flow

The Daily Scrum, held daily and typically lasting 15 minutes, allows team members to share updates on completed tasks, forthcoming plans, and any encountered hurdles, ensuring everyone remains informed without delving into problem-solving.

During the Sprint Planning Meeting, held at the onset of each sprint, the team collaborates to outline the sprint's goals, led by the product owner. They select user stories from the backlog, estimate effort, and break down tasks to initiate the sprint's work. Sprint review and

backlog grooming are two separate ideas. The review allows the developers to voice any questions or potential concerns about the epics and stories for the sprint as well as receive feedback from the team on work completed (*What Is a Sprint Review?*, n.d.). Backlog grooming consists of organizing and cleaning up the stories for the given sprint and preparing the backlog for the next sprint (*Backlog Grooming*, 2021).

At the Sprint Review Meeting's conclusion, the team presents the completed work to stakeholders and the product owner, seeking feedback and focusing on what was accomplished, what remains unfinished, and any necessary alterations. The review allows the developers to voice any questions or potential concerns about the epics and stories for the sprint as well as receive feedback from the team on work completed (*What Is a Sprint Review?*, n.d.).

The subsequent Sprint Retrospective Meeting aims to evaluate the prior sprint, pinpointing successes, failures, and areas for enhancement, fostering introspection and guiding process improvements in the upcoming sprint. Sprint retrospectives allow the team an opportunity to communicate about the previous sprint. This is a learning exercise to improve team efficiency and collaboration through the feedback presented (*What Is a Sprint Retrospective?*, n.d.). Each team member is expected to hold themselves and other team members accountable in a respectful manner.

## 4. Citizens Bank Development Environment

With the intent of creating a prototype demonstrating how banking services can be incorporated into a tuition payment portal, the team set out to build upon the progress of previous projects, understand the current Citizens development pipeline and deliver value according to this system consistently. To achieve this, a lot of early research was focused on understanding the development tools that Citizens' developers and system administrators use and how the previous team, Team Airbus, worked within these constraints.

### 4.1 Development Environment

#### 4.1.1 BitBucket

Bitbucket is a version control system similar to Github. It provides a secure and efficient platform for source code management, offering seamless integration with Atlassian products like Confluence and Jira for comprehensive project support (Kumar, 2022). Our team prioritized accessing the previous MQP team's repository to ensure the integrity and completeness of our tech stack installation. Access to Bitbucket was facilitated through SailPoint, a robust identity, and access management system, which is an essential component in maintaining security and control over project resources within the Citizens Bank infrastructure. Changes made to files stored within BitBucket repositories are tested, built, and deployed with the help of Jenkins and Openshift.

### 4.1.2 VSCode (Integrated Development Environment)

Visual Studio Code (VSCode) served as our preferred integrated development environment (IDE), specifically utilizing version 1.83.1. Developed by Microsoft, VSCode is an open-source, highly acclaimed code editor, prized for its versatility and user-friendliness, making it an ideal choice for our coding requirements (*Why Visual Studio Code?*, 2021). The decision to go with VSCode was significantly influenced by the positive prior experiences of both software engineers on our team, who were already well-acquainted with the tool. Notably, VSCode seamlessly integrated with our Bitbucket repository and played a pivotal role in our workflow, allowing for efficient code changes and quick updates to our code base.

### 4.1.3 Postman

We employed Postman, specifically utilizing version 10.19.7, as a crucial tool for making test API calls to the internal Citizens Bank APIs, an important component of our application. Postman is a versatile and user-friendly platform designed to simplify the testing and documentation of APIs, offering a range of features that enhance the overall API development and collaboration experience (*What is Postman?*, n.d.). With its intuitive user interface, Postman allows users to create and send requests to APIs, view responses, and analyze the data returned. It also offers a robust environment for organizing and managing API endpoints, collections, and test suites. This utilization of Postman not only ensured the reliability and functionality of the bank's APIs but also supported our development and testing processes, significantly contributing to the project's success.

#### 4.1.4 Jest Unit Testing

Unit testing involved creating specific test cases targeting functions in the code base. These tests checked for unexpected or faulty results by providing inputs and expected outcomes to the testing block. The functions had to meet these requirements to ensure the application worked correctly. Our application integrated Jest, a widely-used JavaScript testing framework, providing a robust and efficient platform for writing and executing JavaScript tests (Vaidya, 2023).

To align with best practices, these unit tests were executed every time major changes were made to the code base, or when the application was deployed to the CI/CD pipeline. Developers were encouraged to use Test Driven Development, a practice in which software is written exclusively to satisfy pre-written test cases. Test Driven Development requires unit testing to validate the constantly changing components of an application. Without precautions like this, projects risk accruing technical debt, which describes the features of a software that will need to be fixed and reworked in the future.

The Embedded Tuition Portal includes unit testing of functions related to monetary conversions and formatting utilities. This was to ensure that every piece of information displayed and stored in databases was correct. Within financial systems, rounding error can compound and cause monetary quantities to become inaccurate, resulting in financial loss. To prevent this from happening, the unit tests ensure that the quantities provided by certain functions do not lose precision over multiple function calls. Additionally, monetary values were only rounded when displayed on the dashboard, preventing persistent data from having any rounding error.

## 4.2 CI/CD Pipeline



Figure 3: Redhat CI/CD Pipeline

CI/CD stands for continuous integration and continuous deployment. It is what allows developers to make frequent changes and adjustments to code while maintaining the functionality and integrity of the code (Atlassian, n.d.). This also results in valid builds being almost immediately available on production servers. In a company with the scale and complexity of Citizens Bank, this automated process greatly saves time and enforces the integrity of developing projects.

### 4.2.1 Jenkins

Jenkins is an open-source automation server that governs the various tasks necessary in CI/CD (Jenkins, n.d.). These include building, testing, uploading builds to containers, and deploying builds. This tool runs scripts according to the specifications of several files, called Dockerfile and Jenkinsfile within the repository. After the project dependencies are installed with the version of the software that the tech stack is built on, namely Node.js version 16, the project begins being built with docker.

### 4.2.2 Docker

Docker is a containerization platform that simplifies the process of developing, packaging, and deploying applications. It has garnered widespread popularity due to its ability to

create lightweight, portable, and self-sufficient containers that encapsulate an application and its dependencies. In this context, Docker is used to create an image of the application, a self-contained, all-encompassing, and optimized build that can be run in a container (*Docker Overview*, 2023). These containers are flexible and interchangeable, meaning this build may be run in a correctly configured container, as long as there are enough resources within the system to support the operation of this container.

### 4.2.3 OpenShift

OpenShift is a renowned platform that specializes in managing containers within a distributed computing system (Red Hat, 2023). These containers run Docker images like the one that was built earlier in the pipeline. As soon as an image is uploaded and deployed to a container in OpenShift, the site or application is accessible from the server side, completing deployment. This is the final step in CI/CD, and if done successfully, prepares the built project for testing and use by clients.

## 4.3 Authorization and Security

By accepting credentials that are stored securely in the server-side database, the Embedded Tuition Portal secures student loan and bank account information. Since the data is within Prisma, all student account passwords are hashed and stored in the database. NextAuth is used to verify the credentials of the student first before signing in.

NextAuth creates a session in browser tokens which is checked by the middleware to redirect to login if it is not active (*NextAuth.js*, n.d.). This prevents pages with students' confidential data from being viewed without logging into the application.

## 5. Software Requirements and Design

### 5.1 Software Requirements Gathering

With college students in mind, specifically students at WPI and other similar colleges, the team considered their own college experiences and desires for an improved financial management system. Throughout the sponsor meetings and Sprint 0, an idea for an application targeted towards integrating a student's financial responsibilities with a Citizens bank account. The user stories simplified paying tuition to require the fewest steps necessary. After deciding on integrating WPI's tuition system and Citizens' banking and doing it all within a containerized interface, the team chose a web development framework with strong API integration, a flexible database backend, and an interface appealing to students. The main framework used was Next.js with NextAuth for authentication, since it supported server rendering of pages and simplified API routing. Prisma, an ORM (Object Relational Model) that supports in-memory databases with SQLite3, was used as a database backend to model the storage of student information, including tuition and student loans. This data would be treated as secure and private, necessitating the authentication measures.



### 5.1.1 Use Cases

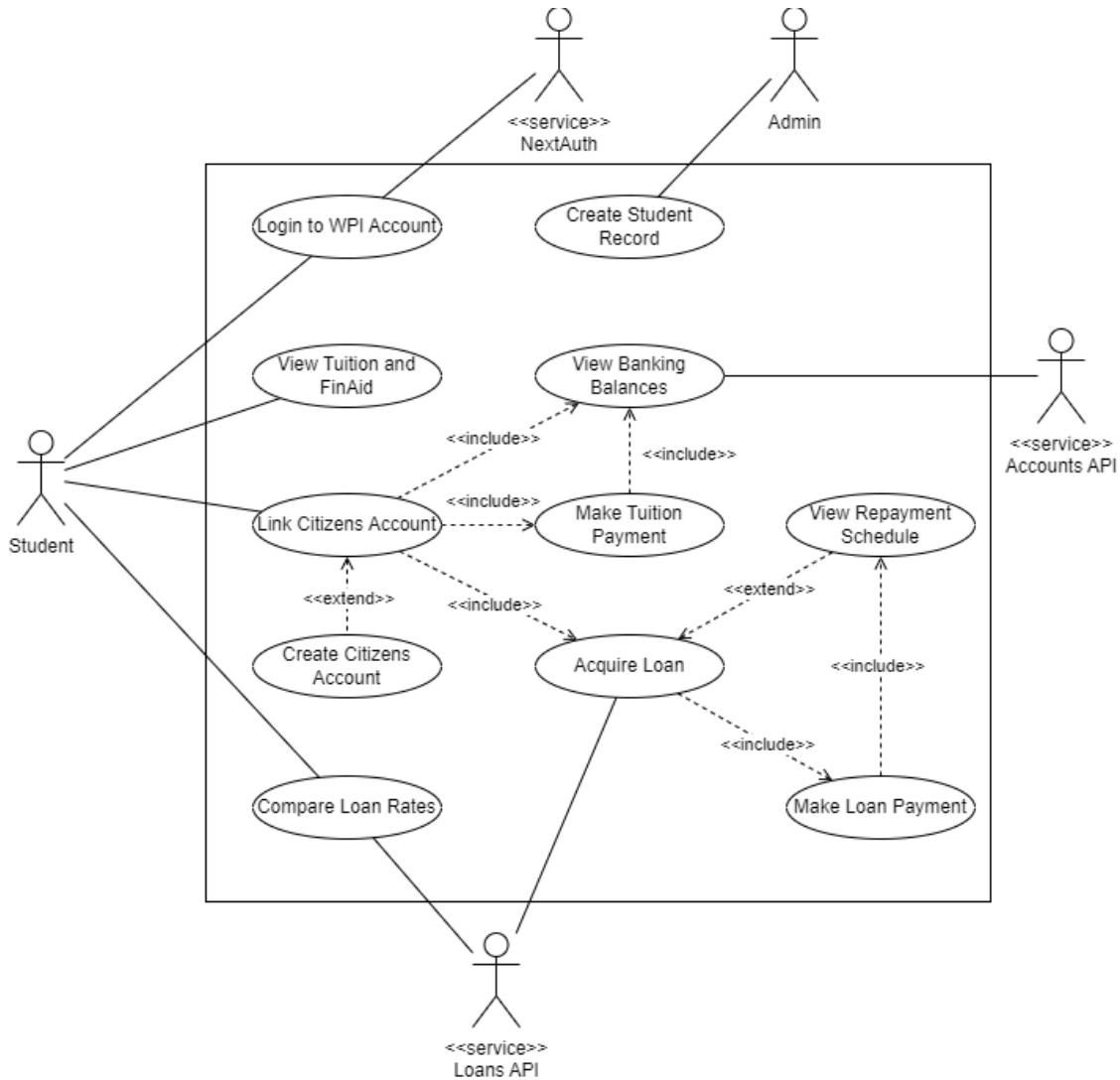


Figure 4: Use Case Diagram

The use cases are a set of combined actions necessary for a student to go from seeing the portal for the first time to making a fully informed decision regarding the payment of their tuition. The tuition payment process involves viewing bank account information, potentially creating a bank account, seeing tuition and financial aid values, and leveraging embedded lending. The portal optimizes the process of financing tuition for students with payment capabilities that are embedded in the application itself.

Dealing with loans is a vague and unfamiliar process to new students, which is why students are given their loan options in a way that is easy to understand. Fine details are also available to compare different types of loans. Loan payments are integrated as well to give the student full control of their repayment schedule. Students can also see future loan payments.

### 5.1.2 FDX Specification

In order to seamlessly integrate with Citizens Bank's internal systems and enhance the functionality of our embedded finance application, the team leveraged the Financial Data Exchange (FDX) specification. This standardized framework not only ensures the integrity of financial data but also enhances the functionality of our application. Our application employs a sophisticated authentication mechanism to strengthen the security of our interactions with Citizens Bank's internal SIT APIs. This involves the use of a client ID and client secret, forming a robust authentication layer that guarantees the confidentiality and integrity of the financial data exchanged between our application and Citizens Bank's systems.

Facilitating this secure connection are multiple FDX (Financial Data Exchange) endpoints, API services that provide structured data for applications. Foremost among these is the Citizens Loan Data Endpoint, which serves as the gateway to comprehensive loan information for students. By querying this endpoint, our application provides users with an easily comprehensible overview of their loan options, ensuring that the nuanced details of loan offerings are presented in a user-friendly manner.

- GET/consumer/rates/{product}

This gets the rates of Citizens products and all its sub-projects along with the payment calculations, according to the loan amount, number of years, rate type, and repayment type. For example:

```
"scenarios": [
  {
    "loanAmount": 10000,
    "term": 5,
    "rateType": "Fixed",
    "repaymentType": "Interest Only",
    "repaymentExample": {
      "min": {
        "rate": "7.13",
        "APR": "7.14",
        "monthlyPayment": "198.69",
        "totalRepayment": "14714.79"
      },
      "max": {
        "rate": "11.95",
        "APR": "11.96",
        "monthlyPayment": "222.31",
        "totalRepayment": "18020.26"
      }
    }
  },
  {
    "loanAmount": 10000,
    "term": 5,
    "rateType": "Fixed",
    "repaymentType": "Immediate",
    "repaymentExample": {
      "min": {
        "rate": "7.13",
        "APR": "7.14",
        "monthlyPayment": "195.2",
        "totalRepayment": "11711.72"
      },
      "max": {
        "rate": "11.95",
        "APR": "11.97",
        "monthlyPayment": "215.85",
        "totalRepayment": "12950.92"
      }
    }
  },
  {
    "loanAmount": 10000,
    "term": 5,
    "rateType": "Variable"
```

Complementing this is the Citizens Banking Account Data Endpoint, smoothly integrating banking account information into our user interface. This not only simplifies the user

experience but also centralizes critical financial information, empowering users to manage their financial affairs with efficiency.

- POST/checking/details/query

```
{
  "accountNumber": "4040608864",
  "accountDescription": "One Deposit Checking",
  "accountSubType": "INTEREST_BEARING_CHECKING_ACCOUNT",
  "productCode": "222",
  "availableBalance": "100.00",
  "availableCheckingBalance": "100.00",
  "currentCheckingBalance": "100.00",
  "interestRate": 2.6,
  "priceRegion": 0,
  "accountRelationshipType": "EMPLOYEE OF BANK",
  "relationshipManager": "B2B",
  "isAcquiredAccount": "TRUE",
  "acquiredFromBankName": "Hongkong and Shanghai Banking Corporation",
  "acquiredFromBankCode": "HSB",
  "statementCycle": "BANKING DAY",
  "accountStatus": "NORMAL",
  "branchNumber": "261",
  "checkingAccountType": "NORMAL",
  "branchName": "Harborcreek Giant Eagle",
  "bankMarketName": "Philadelphia",
  "monthToDateAverageBalance": "100.00",
  "taxId": "xxx-xx-xxxx",
  "taxIdType": "TIN",
  "lastDepositAmount": "100.00",
  "lastDepositDate": "1990-04-06",
  "lastStatementBalance": "100.00",
  "lastStatementDate": "1990-04-06",
  "lastActivityDate": "1990-04-06",
  "nextStatementDate": "1990-04-06",
  "accountOpenDate": "1990-04-06",
  "accountClosedDate": "1990-04-06",
  "eStatementFlag": "ENROLLED",
  "creditLimit": "100.00",
  "interestAmountCurrentYear": "100.00",
  "interestAmountLastYear": "100.00",
  "lastInterestAmount": "100.00"
}
```

By harnessing these FDX endpoints, our embedded finance application transforms the user interface into a centralized hub, optimizing the decision-making process for tuition payments and financial planning.

### 5.1.3 User Stories and Epics

Sprint	User Story	Points	Type	Assigned Epic
0	Past Project Code Analysis	0	Spike	Software Prototype Mockup
0	Confluence Project Page	0	Spike	Financial Dashboard
0	Decision on deliverable for the customer (WPI Students)	0	Spike	Financial Dashboard
0	Decision on technology stack	0	Spike	Financial Dashboard
0	Research loans offered by Citizens	0	Spike	Financial Dashboard
1	Create Bitbucket repository for code	0	Spike	Login and Account Authenticator
1	Developer creation of mock WPI student accounts in local database	3	Story	Create WPI mock account
1	Decide on database	0	Spike	Software Prototype Mockup
1	Mock student financial information stored from database and displayed on dashboard	2	Story	Financial Dashboard
1	WPI Student Login Credentials	3	Story	Create WPI mock Account
2	Personalized Dashboard	3	Story	Financial Dashboard
2	Low fi prototype	5	Story	Software prototype mockup

2	Citizens Bank account login within WPI dashboard	5	Story	Financial Dashboard
2	See checking account balance for multiple accounts	3	Story	Financial Dashboard
2	View and visualization of Citizens loan options and information	3	Story	Financing Tuition payments
3	Find Testing Frameworks	0	Spike	Software Prototype Mockup
3	Loan Cost Calculations	5	Story	Financing Tuition Payments
3	Define the components of a students account balance	1	Story	Financial Dashboard
3	Loan Application	1	Story	Financing Tuition Payments
3	Loan Confirmation Page	3	Story	Financing Tuition Payments
3	Citizens Bank account login within WPI dashboard	5	Story	Financial Dashboard
4	Find Testing Frameworks	0	Spike	Software Prototype Mockup
4	Connection to Citizens Checking Account APIs	0	Spike	Financing Tuition payments
4	Ensure full deployment to Citizens pipeline	0	Spike	Financial Dashboard

4	Research to modernize/simplify UI dashboard	3	Story	Financial Dashboard
5	Display account owner name in dashboard	1	Story	Financial Dashboard
5	Financial Aid Offers	1	Story	Financial Dashboard
5	Loan Repayment Visualization	5	Story	Financing Tuition Payments
5	Modify capstone presentation	1	Story	Financial Dashboard
6	Iterate Dashboard	1	Story	Financial Dashboard
6	Send academic report to bank	1	Story	Financial Dashboard

Table 1: User Stories and Epics

## 5.2 Design

### 5.2.1 Functional and Non-functional Requirements

As a functional requirement, this prototype application must allow a student to access multiple financing options for their tuition while displaying a dashboard summarizing the tuition costs, financial aid awards, and total remaining costs. To secure student and bank account data, the application must have a secure authorization system, and verify that a student’s bank account and WPI credentials are properly linked. It must also support the retrieval of data from Citizens' systems. For this prototype to become a fully-fledged product, it has to be capable of retrieving WPI’s tuition data as well as financial aid data.

The non-functional requirements are derived from the tech stack and development environment in which this project was launched. It must run in a containerized environment, specifically Docker. It must support a storage of example student data to be used in tuition calculations.

### 5.2.2 System Architecture

The prototype portal application is a containerized full-stack web application deployed to Openshift. The application uses NextAuth to authenticate WPI students within the application, and student/ tuition data is modeled by SQLite3, an in-memory database (*In-Memory Databases*, n.d.). Once a student is authenticated with WPI credentials, they have access to their confidential tuition and financial data as well as their linked Citizens account data which contains checking and savings information. The bank account data and loan rates are retrieved by the FDX API (Citizens internal APIs).



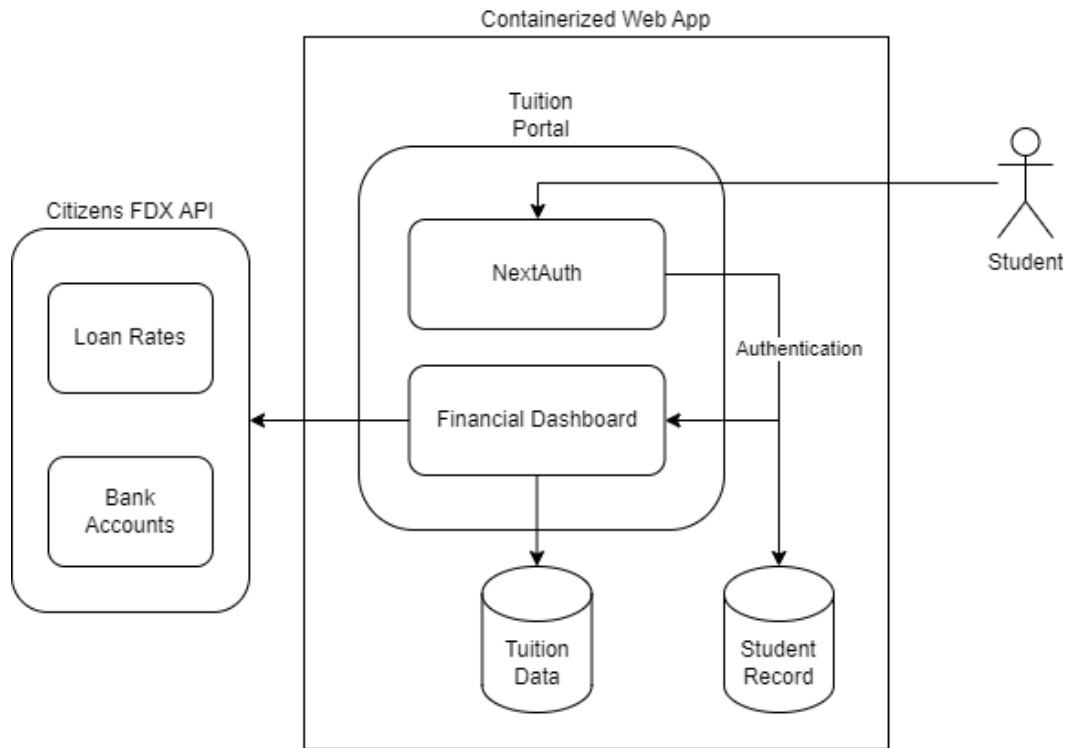


Figure 5: Tuition Portal System Architecture

### 5.2.3 Database Schematics

The database contains information about students and their tuition values, as well as any Citizens Bank accounts that have been confirmed. Moreover, the data that is pulled encompasses all important student information including ID, email, name, password, year, and financial aid. Key tuition information is also contained, including course fees, meal plans, housing, insurance and living fees. Citizens Bank accounts that have been connected to the dashboard also contain information for both the confirmed checking and savings accounts with API calls. Also, data on the loans is stored to help students see all their financial conditions in one place. This is to simulate the access of data from WPI's backend in order to supply the data on the dashboard. The original database configuration is shown below, but since it was over complicated and contained too many broad details, it was greatly simplified.

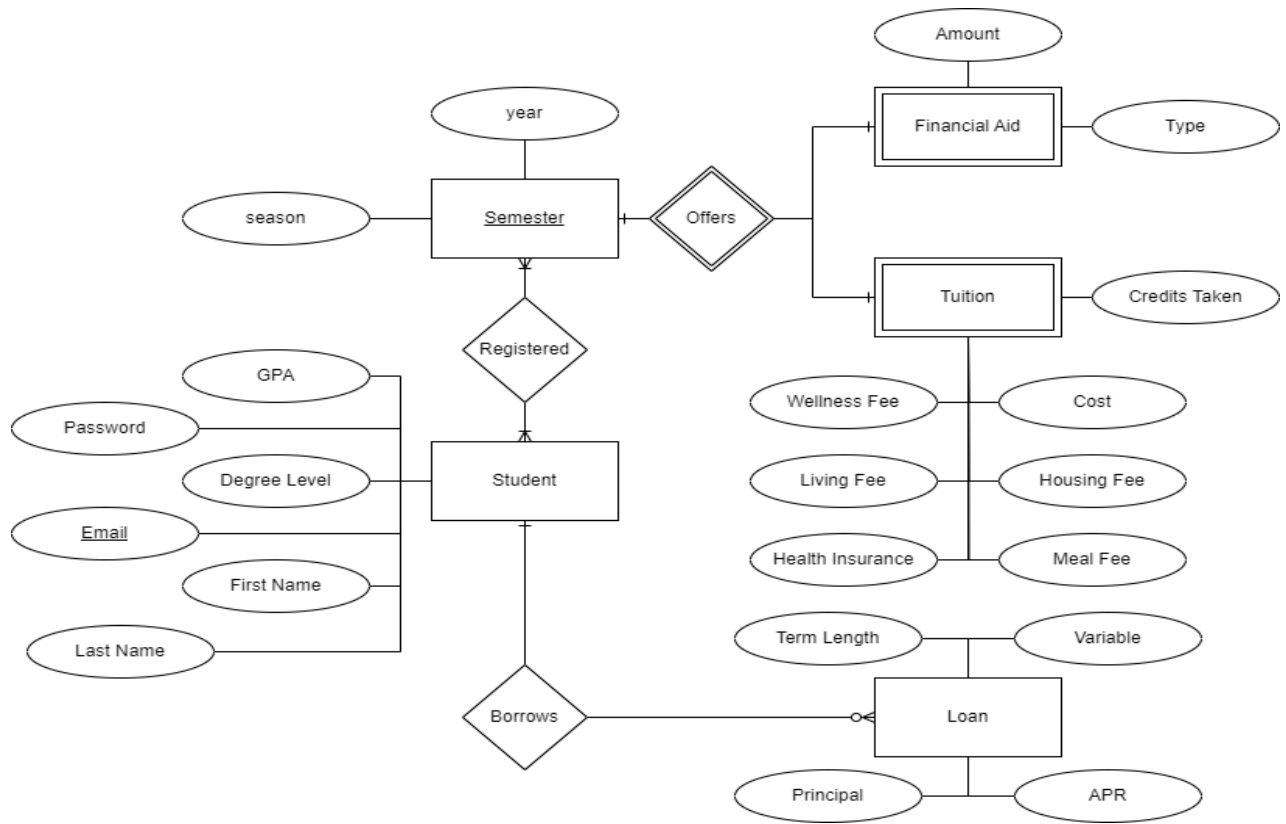


Figure 6: Initial Database Schematic

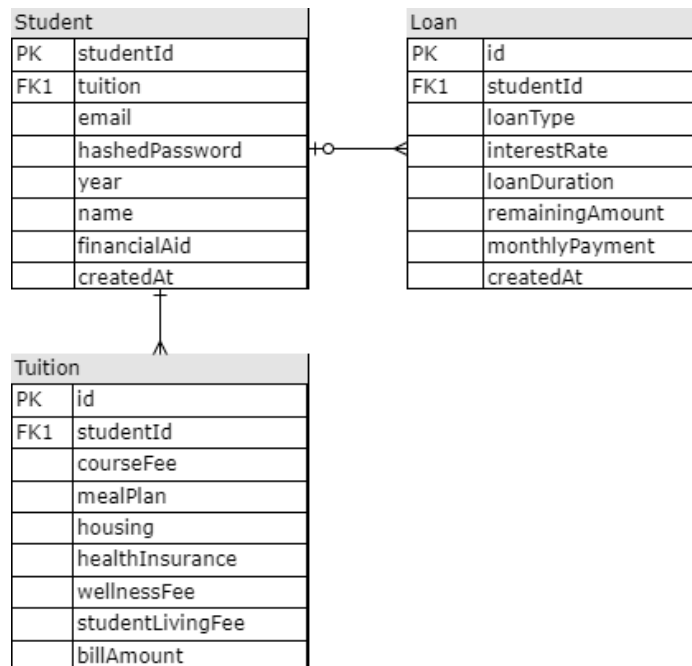


Figure 7: Application Database Schematic

## 6. Software Development

Key aspects of Agile methodology that were employed during the course of this project included reducing a project into iterations called sprints and improving team value by placing individuals in appropriate roles and allowing them to flourish. The Agile philosophy employed even helped the team to communicate effectively and choose the name of “Team Scholar” for itself.

The project was broken down into seven one-week sprints where team members created, altered, and removed use cases, which were then categorized into stories and epics. This was a slight transition from the sponsor's two-week sprint iterations. Team members met to discuss progress, potential questions, or blockers in meetings called scrums.. Along with the daily scrum meetings, the team took part in several Citizen-led ceremonies. These ceremonies included sprint planning meetings, sprint review/backlog, and the sprint retrospective.

Jira was utilized as agile management software throughout the project and allowed stories to be easily organized. Estimation and allocation of time for software components allowed the team to adjust sprints on the go and respond to blockers quickly and efficiently. Work was done in a hybrid manner, with team members meeting remotely for daily scrums and presentations.

	Sprint 0	Sprint 1	Sprint 2	Sprint 3	Sprint 4	Sprint 5	Sprint 6
<b>End Date</b>	11/01	11/08	11/15	11/22	11/29	12/06	12/13
<b>Report</b>							
<b>Figma Interface</b>							
<b>Prototype MVP</b>							
<b>Prototype Iteration</b>							
<b>Auth/Login Demo</b>							

Table 2: Planned Development Timeline

### 6.1 Sprint 0

Points	User Story	Type	Status
0	Past Project Code Analysis	Spike	Done
0	Confluence Project Page	Spike	Done
0	Decision on deliverable for the customer (WPI Students)	Spike	Done
0	Decision on technology stack	Spike	Done
0	Research loans offered by Citizens	Spike	Done

Table 3: Sprint 0 User Stories and Epics

Total Points: 0

In Sprint 0, our team kicked off with a phase focused on getting things ready, and it involved some important activities. This sprint was a 0-point sprint and mainly revolved around spikes. These spikes are essentially time-limited user stories designed to tackle important research questions and challenges. During this sprint, we completed a total of five spikes to set the stage for our project with Citizens Bank.

In our first spike, we focused on a thorough analysis of the code from the previous year's MQP team project with Citizens. This helped us become well-acquainted with Citizens' technology stack and gain insights into our upcoming application's architectural nuances. Once we had everything up and running, we could set up the Airbus web app locally, enabling us to dissect the codebase and understand the routing mechanisms and API interactions with Citizens' internal systems. This phase also provided us with valuable hands-on experience with Next.js and TypeScript.

The team then created our Confluence Project Page, a team workspace that allows for enhanced collaboration. Used for project documentation, the WPI team added personal information, such as a headshot, major/field of study, and a LinkedIn account. Primarily used for the Frontier Pod to become familiarized with the team.

In the next spike, we focused on defining a deliverable that would cater to our customers, and we settled on a dynamic dashboard. This dashboard was all about showing students their tuition and financial aid details while making it super easy for them to log in with their Citizens Bank credentials. The goal was to embed Citizens Financial Services and give users the tools they need to handle their tuition finances effectively, providing them with insights into loan options and helping them make informed choices. After careful consideration, we decided that building a new Next.js application using JavaScript from the ground up would be the most

effective approach, as it would enable us to tailor the platform precisely to our specific project requirements, ensuring a specialized and focused solution.

In our final spike, we delved into thorough research on the various undergraduate loan options offered by Citizens Bank, recognizing their significance as a pivotal component of our project deliverable. This allowed us to gather essential information and insights into these loans, ensuring that our dashboard would provide users with comprehensive and accurate loan data. Loans offered by Citizens for undergraduate students are categorized by duration, variable vs fixed, Immediate payment, Interest-only payment, and deferred repayment. The loan duration signifies how long the repayment lasts. In a fixed loan, the interest rate remains constant throughout the loan's lifespan, whereas a variable rate changes in response to market conditions. Moreover, repayment terms for loans can be immediate, involving monthly payments from the start; interest-only, where one pays the accrued interest each month while in school; or deferred, allowing repayment to begin after graduation (Emiliano, 2023). Annual percentage rate, or APR refers to the yearly interest generated by a sum that is charged to borrowers that is expressed as a percentage (Fernando, 2023). Outlined below are the options offered by Citizens Bank.

<b>60 Months</b>	<b>Variable</b>		<b>Fixed</b>	
\$10,000 Loan Principal	Lowest	Highest	Lowest	Highest
<b>Immediate Payment</b>				
Interest Rate	9.33%	13.19%	7.65%	11.74%
APR	9.34%	13.20%	7.66%	11.75%
Monthly Payment	\$204.48	\$221.31	\$197.37	\$214.91
<b>Total to Pay Back</b>	<b>\$12,268.67</b>	<b>\$13,278.50</b>	<b>\$11,841.65</b>	<b>\$12,894.58</b>

<b>Deferred Repayment</b>				
Interest Rate	9.33%	15.25%	7.65%	13.57%
APR	8.49%	13.20%	7.07%	11.90%
Monthly Payment	\$285.75	\$382.32	\$261.44	\$353.14
<b>Total to Pay Back</b>	<b>\$17,144.14</b>	<b>\$22,939.13</b>	<b>\$15,685.84</b>	<b>\$21,187.98</b>

Table 4: Undergraduate student loan 5-Year Repayment

<b>120 Months</b>	<b>Variable</b>		<b>Fixed</b>	
\$10,000 Loan Principal	Lowest	Highest	Lowest	Highest
<b>Immediate Payment</b>				
Interest Rate	9.07%	12.94%	7.40%	11.49%
APR	9.08%	12.95%	7.41%	11.50%
Monthly Payment	\$124.29	\$144.38	\$116.07	\$136.69
<b>Total to Pay Back</b>	<b>\$14,914.07</b>	<b>\$17,324.07</b>	<b>\$13,928.40</b>	<b>\$16,401.49</b>
<b>Deferred Repayment</b>				
Interest Rate	9.07%	15.25%	7.40%	13.57%
APR	8.46%	13.63%	6.99%	12.27%
Monthly Payment	\$172.28	\$260.35	\$152.50	\$234.01
<b>Total to Pay Back</b>	<b>\$20,672.99</b>	<b>\$31,240.62</b>	<b>\$18,299.61</b>	<b>\$28,080.33</b>

Table 5: Undergraduate student loan 10-Year Repayment

<b>180 Months</b>	<b>Variable</b>		<b>Fixed</b>	
\$10,000 Loan Principal	Lowest	Highest	Lowest	Highest
<b>Immediate Payment</b>				
Interest Rate	9.19%	13.09%	7.45%	11.64%
APR	9.20%	13.10%	7.46%	11.65%
Monthly Payment	\$100.31	\$123.18	\$90.77	\$114.46
<b>Total to Pay Back</b>	<b>\$18,054.29</b>	<b>\$22,169.88</b>	<b>\$16,336.57</b>	<b>\$20,599.49</b>
<b>Deferred Repayment</b>				
Interest Rate	9.32%	15.40%	7.65%	13.72%
APR	8.79%	13.96%	7.29%	12.57%
Monthly Payment	\$141.15	\$228.99	\$121.66	\$202.02
<b>Total to Pay Back</b>	<b>\$25,406.25</b>	<b>\$41,213.78</b>	<b>\$21,895.66</b>	<b>\$36,362.05</b>

Table 6: Undergraduate student 15-Year Repayment

### 6.1.1 Sprint 0 Retrospective

During the initial Sprint, the team laid the groundwork for the deliverable and defined the scope of the project. This involved designing the prototype of the interface and creating an Entity Relational Diagram of the database necessary to model the record of a student’s tuition and financial aid information. Additionally, the team gained experience in the Citizens tech environment.

Throughout the first sprint, the team found many discussion topics went well and met expectations. Most notably, good collaboration and communication both internally and with the



sponsor, a willingness to work on a new tech stack, and in-person work meetings mid-sprint. However, the team found items to improve upon after the conclusion of the initial sprint, specifically in looking for opportunities to split stories during refinement.

To solve this, the team is looking to find more accurate ways to estimate our stories and ensure all stories have clear acceptance criteria. Ultimately the team agrees that taking the time to reflect on what went well and what to improve upon, will promote a flexible and more efficient work environment.

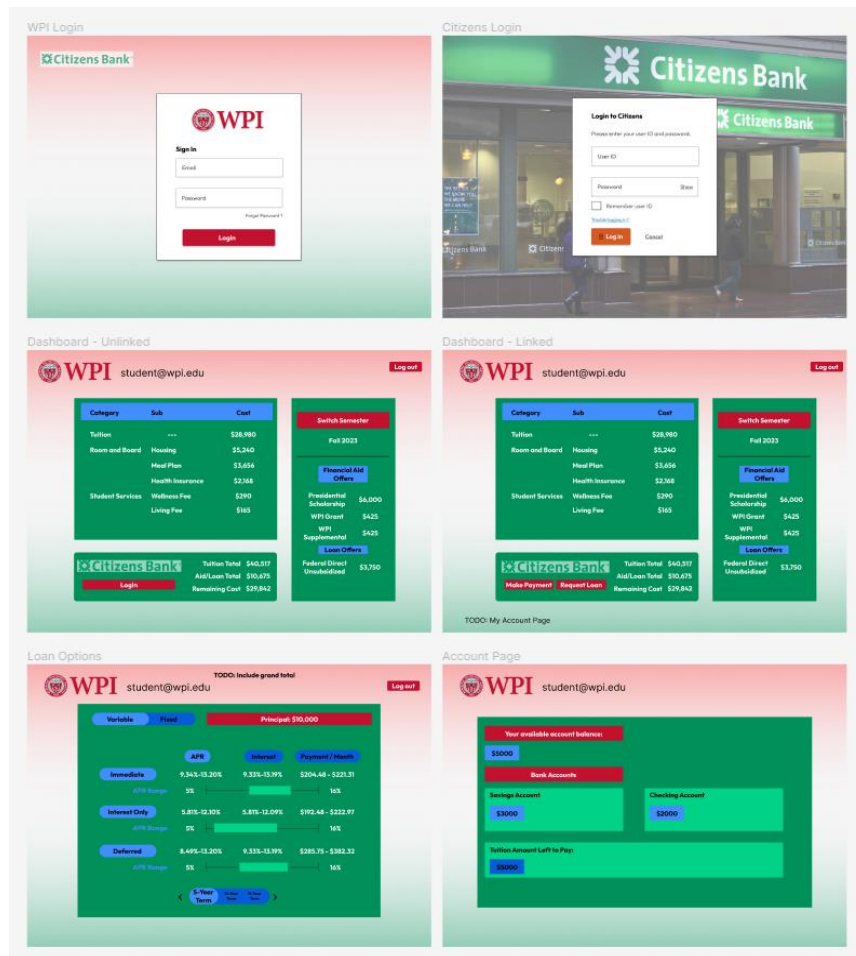


Figure 8: Initial interface design

## 6.2 Sprint 1

Points	User Story	Type	Status
0	Create Bitbucket repository for code	Spike	Done
3	Developer creation of mock WPI student accounts in local database	Story	Done
0	Decide on database	Spike	Done
2	Mock student financial information stored from database and displayed on dashboard	Story	Done
1	WPI Student Login Credentials	Story	Done

Table 7: Sprint 1 User Stories and Epics

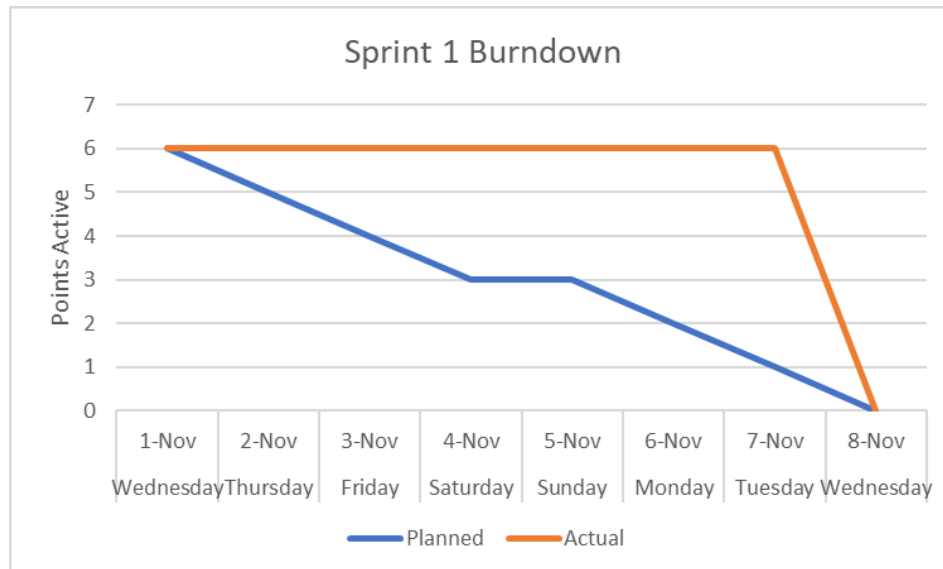


Figure 9: Sprint 1 Burndown Chart

Total Points Completed: 6

In Sprint 1, our team focused on setting up the foundation for our tech stack as we developed the Citizens Bank application. This sprint was an 8-point sprint, with three stories and two spikes. Our first step was getting a Bitbucket repository in place to centralize our work. With the repository ready, we started development by creating key components like the login screen and a developer registration screen, which will be used to generate mock WPI accounts for testing purposes. Simultaneously, we integrated an SQLite3 database into our application to handle data storage and synchronization for client information. This database plays a crucial role in our user authentication process, ensuring secure access.

We also worked on implementing page routing logic and user authentication, vital for providing a seamless user experience and maintaining data security. A significant achievement was designing and configuring the dashboard screen to retrieve user data once they are authenticated, providing users with personalized and relevant information.

While we successfully completed all our user stories, one important task was still pending: deploying our application on the Citizens Bank pipeline. To make this happen, we went through the process of registering our application within the Citizens' deployment configuration repository and submitted a pull request. We are now awaiting approval for the pull request. This provided the team with experience with real-world bureaucratic deadlines. Once approved, the team will be able to push our code to the main branch and have it run on the Citizens Bank pipeline, marking a critical milestone in our project's development.

### 6.2.1 Sprint 1 Retrospective

During this week's sprint, our team laid the foundation for the tech stack that will serve as the backbone of our application. The team was excited with the progress made by the conclusion of the sprint, as all eight points were completed and closed. The goal was to establish

the initial setup of our application. We created the login screen, register screen, and user dashboard screen, ensuring a seamless user interface. The team also established robust user authentication and logging procedures and set up the infrastructure to read and retrieve data from the database.

Throughout this sprint, the team found many discussion topics continued to work well, as a collaboration between the team and sponsor, in-person meetings, and the creation of a demo show a great deal of work that the team is excited about was completed. Moreover, the team continues to make great progress on the academic report. However, the team found items to improve upon, most notably coordinated communication with DevOps. It should also be noted that severe entity-wide VPN issues affected the team.

The team compiled action items such as if stories have to roll over due to the business making sure it is communicated and documented, and a full team visit to Citizens' campus to meet the team and get employee badges completed. The team made great progress on the deliverable and academic report and is very grateful for the opportunity to have met the Citizens team in person and looks forward to more visits down to the Citizens campus.

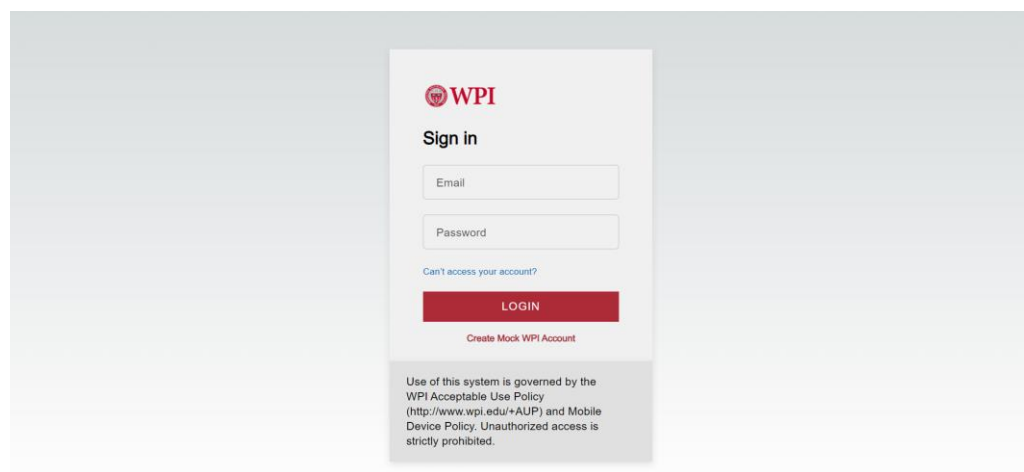


Figure 10: Financial Dashboard Login Screen

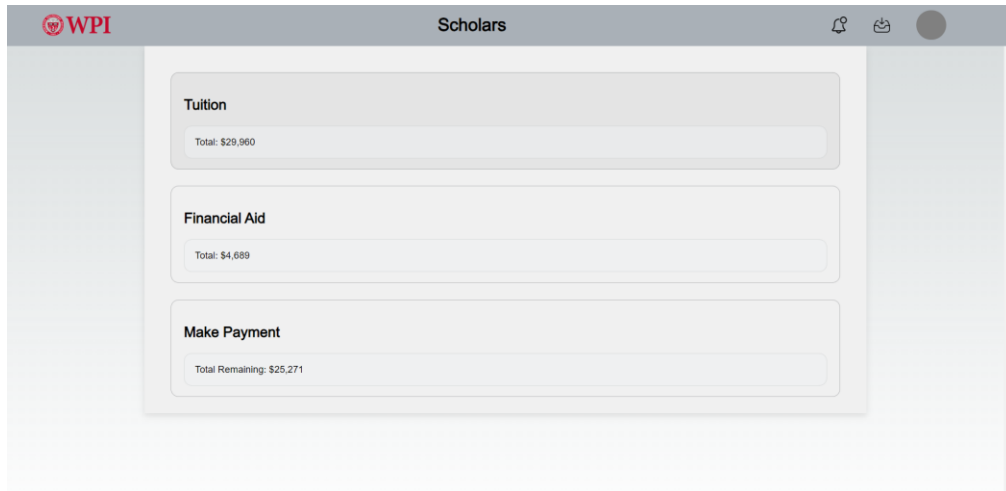


Figure 11: Financial Dashboard Homepage

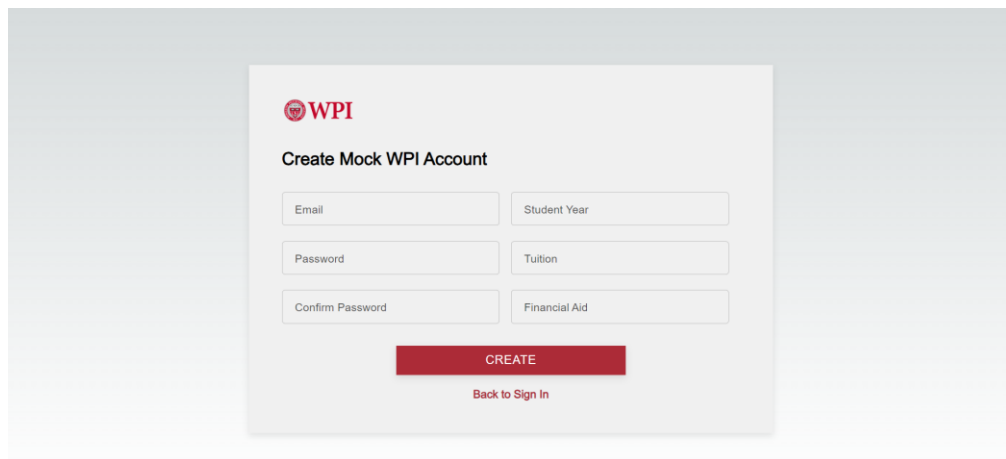


Figure 12: Mock Student Account Screen

## 6.3 Sprint 2

Points	User Story	Type	Status
3	Personalized Dashboard	Story	Done
5	Low fi prototype	Story	Done
5	Citizens Bank account login within WPI dashboard	Story	Rolled over
3	See checking account balance for multiple	Story	Rolled over

	accounts		
3	View and visualization of Citizens loan options and information	Story	Done

Table 8: Sprint 2 User Stories and Epics

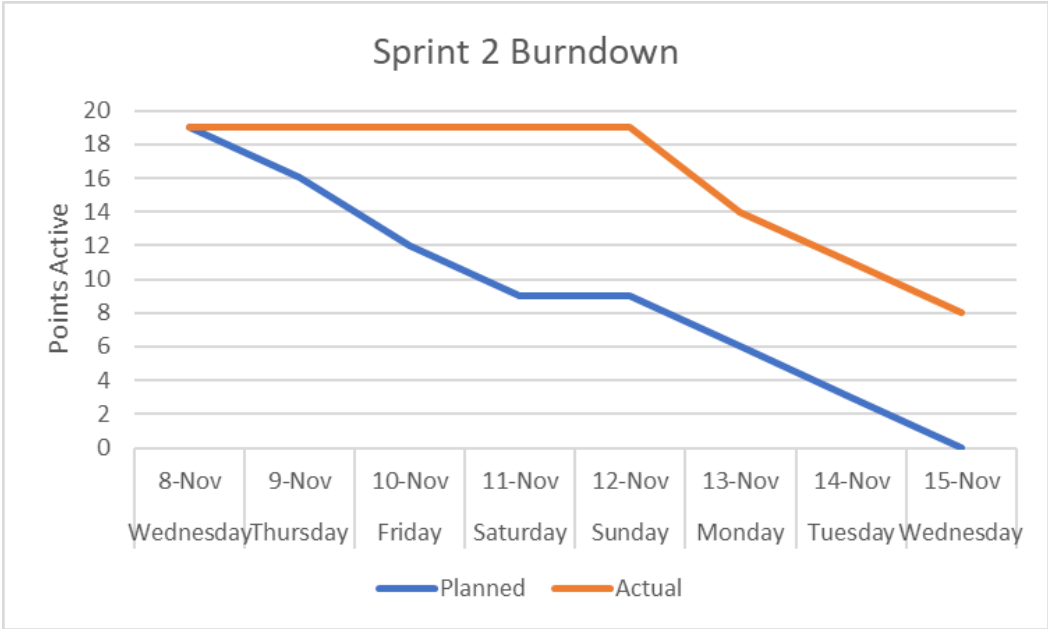


Figure 13: Sprint 2 Burndown Chart

Total Points Completed: 11

In Sprint 2, the team worked on our application. Work was done so the student financial portal displays customer financial information to the user. The goal was to log in to a Citizens Bank account within the WPI dashboard using a username and password so that the student could see Citizens’ loan options and visualization of loan APR, interest, and monthly/sum of repayments for each option. The dashboard was designed to have a simple UI and define any financial terms to allow for a simple interaction with the interface. Our team understands the financial industry is full of unfamiliar jargon, and college students may not be familiar with loans and how they operate, so creating a user-friendly user face was paramount. We added a link to

our old dashboard for users who are more familiar with loans to use this tool as a calculator to make side by side comparisons of different options. As previously mentioned, a large part of this sprint took place in understanding how loans operate behind the scenes and how to differentiate the immediate and deferred repayment options. Immediate represents, “principal and interest payments immediately after the loan is fully disbursed”, and deferred represents “flat payment while in-school, graduated repayment (payments increase over time)” (Finaid, n.d.).

Our team also worked on allowing the student to view checking and savings account balances for combined and or multiple accounts within the WPI dashboard. Having this feature allows the student to quickly assess their financial situation and allows for decisions on payments for loans without having to view multiple screens at once. If the user is an existing customer or Citizens, they can login using their credentials, however if they are not a customer, they will be asked to create an account. This is an incentive for Citizens as this will add new customers to the bank. Additionally, this adds value for WPI in a variety of ways. The dashboard allows for a more seamless experience for students, as banking and loan information are now embedded. Moreover, the bursar's office at WPI can receive a greater amount of on time payments because banking and loan information will be centrally located in a familiar and simple dashboard.

Not all stories were completed in full, as the user stories “Citizens Bank account login within WPI dashboard” and “See checking account balances for multiple accounts” rolled over into the next sprint. Good progress was made towards these stories, as these pieces were added to the dashboard, however, they are not pulling from Citizens APIs currently, as they were hard-coded at the end of this sprint. For this reason, we decided to keep the stories open and move them into the next sprint.

### 6.3.1 Sprint 2 Retrospective

After laying the groundwork in Sprint 1, the team focused on integrating further with the Citizens Bank Team, addressing issues with deploying our application and implementing connections between Citizens APIs/accounts and our application.

In the weekly visit to the Citizens Johnston Campus, two of the WPI team members met the members of the Pod in person for the first time. As a full team, we then went down to the campus once more during the sprint, as the team feels working in person with the Frontier Pod is extremely beneficial. In turn, we received some clarification on how to access and use internal and external Citizens APIs, allowing us to start implementing them. With the newly acquired internal loans API, a loans page was created, showing loans that are possible for students to obtain, with different options based on the rate type, repayment plan, and term length. Choosing between fixed and variable rate loans, as well as 5, 10, and 15-year lending terms, and immediate vs deferred repayment options, the student can compare and decide upon what works best. Although we still had issues with the CI/CD pipeline, we were able to get a configuration set up in their system after a call with a developer. We now can run containerized apps on their system but have not been able to do so yet.

Significant work was done this week on the application and the scope of the deliverable was clearly defined while the team was working in person with the Frontier Pod. Conversations regarding expectations of attendance also arose. This expectation was created early in the term, however it had to be communicated again that all Citizens and WPI ceremonies are mandatory. The team understands schedules are constantly being modified, however unless there is a conflict all ceremonies must be attended to better foster a collaborative environment. Moreover, the team, sponsors, and the advisors agree that we must do a better job at this, and we look forward to



improving this. On the other hand, during this sprint we initially demonstrated a dashboard to both the Citizens team and WPI advisors, however after many conversations, we concluded the dashboard was too cluttered and not user-friendly. The old dashboard will now be moved to a section called “Student Financial Links” and can be used as a calculator to quickly compare costs of loans. Our new design of the dashboard focuses on simplicity, being clearly defined, and allows the users simple access.

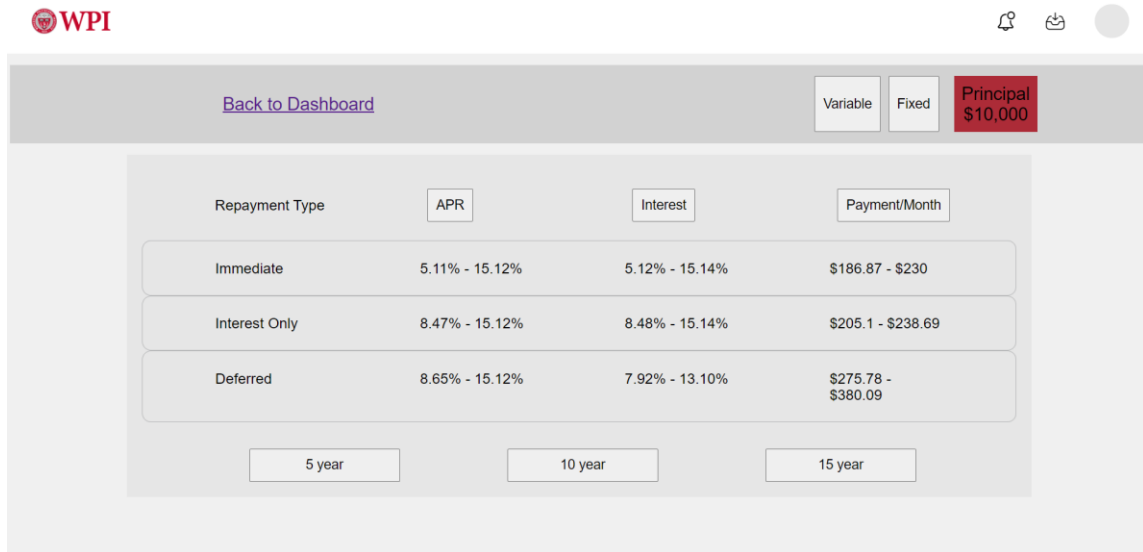


Figure 14: Initial Citizens loan dashboard

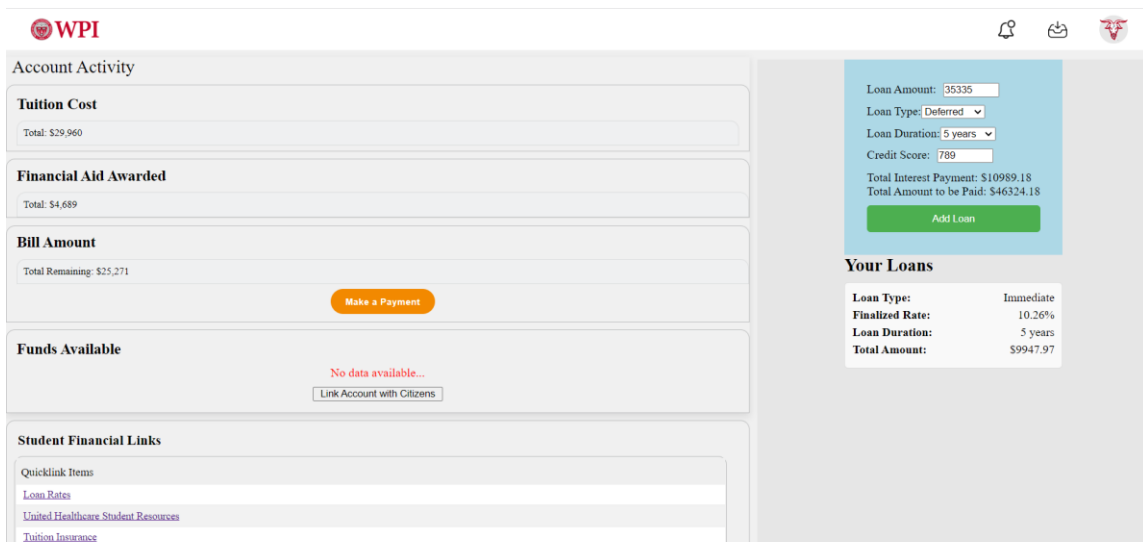


Figure 15: Updated Citizens loan dashboard

## 6.4 Sprint 3

Points	User Story	Type	Status
0	Find Testing Frameworks	Spike	Rolled Over
5	Loan Cost Calculations	Story	Done
1	Define the components of a students account balance	Story	Done
1	Loan Application	Story	Done
3	Loan Confirmation Page	Story	Done
3	See checking account balance for multiple accounts	Story	Done
5	Citizens Bank account login within WPI dashboard	Story	Rolled Over

Table 9: Sprint 3 User Epics and Stories

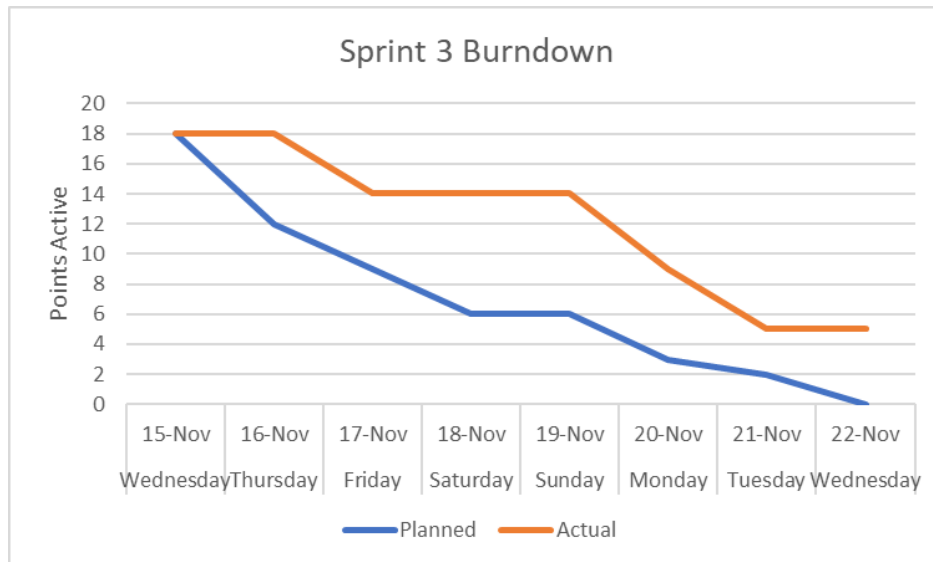


Figure 16: Sprint 3 Burndown Chart

Total Points Completed: 13

During this sprint, the team set out to capture all the functionality associated with the financial portal, modeling how a real user would be able to go through the entire tuition payment process. At first, discussions were held about the elements of payment, where they should be located, and how they will work. Loans were a specifically complex issue to tackle. We decided on a simplified system in which a credit score would determine how favorable of a rate a student borrower could access.

While simultaneously keeping an eye on pipeline operations and the progress of approval for deposit accounts APIs, the developers created a user interface with placeholder data to simulate the full range of repayment options. With mock account balances, the student would be able to select an amount to repay directly from an account. The loans would be a separate option, given to the student at their discretion.

To simplify loans, users would be presented with immediate and deferred options, always at a fixed rate. Since variable rate loans can offer risk that a student may not be fully informed of, they are reserved for the more detailed loan screen. Interest only loans have also been omitted, leaving students with two distinct loan options. This is to make sure that a student is not confused or overwhelmed by the number of choices they need to make. However, an explanation of these options is still necessary.

#### 6.4.1 Sprint 3 Retrospective

This week proved instrumental in developing the functionality of the dashboard. Through multiple conversations with the team at Citizens and WPI, the team was able to successfully implement the calculations for loans and implement the ability to apply for a loan, pay for it and view account balance information. However, the team is still not on Citizens' pipeline and the

bank account information within our dashboard is not currently connected to Citizens internal checking APIs.

Communication and the weekly visit to the bank's campus continue to work well for the team. Leveraging Frontier Pod's expertise allowed the team to understand that the dashboard's UI was far too complex and needed to be simplified. In addition to this, research will be done to get a vision to create a more modernized dashboard that students and users will be more familiar with.

In the coming sprints, the team must prioritize getting on the pipeline, as it was communicated to us that any further work can no longer be marked as done without having access to the pipeline. It has now spanned multiple sprints where the team has not had access to Citizens' pipeline and the team must communicate with different individuals to expedite this process. Another action item is gaining access to internal checking account APIs, as the developers have hard coded information as a placeholder for the time being. Once sufficient access to the pipeline is granted and the team can connect to the necessary APIs, both the spike and story that rolled over can be completed.

## 6.5 Sprint 4

Points	User Story	Type	Status
0	Find Testing Frameworks	Spike	Done
5	Citizens Bank Account Login within WPI dashboard	Story	Done
0	Connection to Citizens Checking Account APIs	Spike	Done

0	Ensure full deployment to Citizens pipeline	Spike	Done
3	Research to modernize/simplify UI dashboard	Story	Done

Table 10: Sprint 4 User Epics and Stories

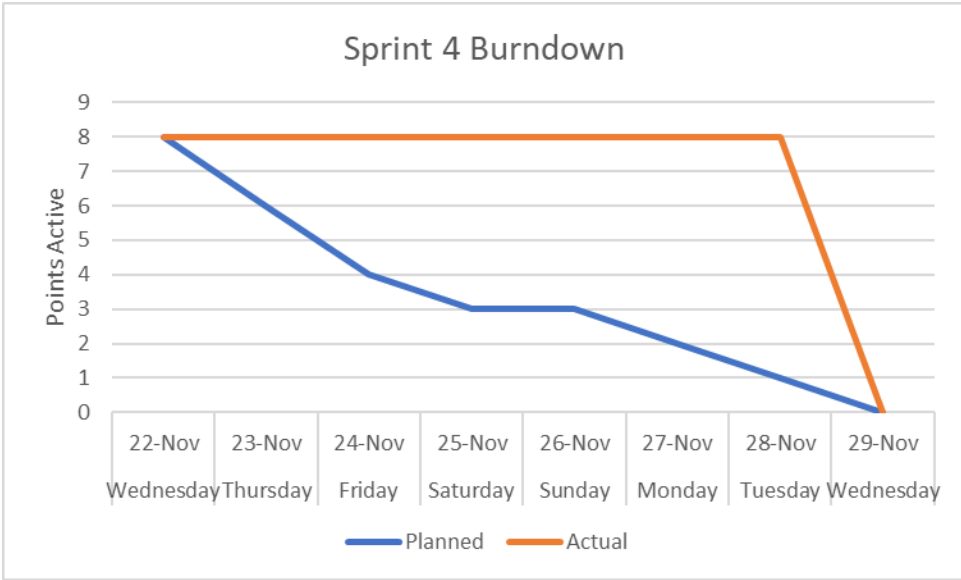


Figure 17: Sprint 4 Burndown Chart

Total Points Completed: 8

During this sprint, our primary focus was to deploy our application to the Citizens pipeline. Despite facing challenges initially with Citizens VPN blocking access to essential software binaries for Prisma, our chosen ORM, we successfully overcame this hurdle. After exploring alternative options, including other ORMs and databases, we made crucial changes to our application structure. These changes allowed us to deploy the current app, containing all code and functionality to Citizens’ pipeline, while still utilizing Prisma and SQLite3 as an in-memory database. This achievement marks a significant milestone for the team, providing a solid foundation for the upcoming sprints. In parallel with deployment efforts, we decided on the

testing framework for our application. We chose Jest, a powerful JavaScript testing framework, to ensure the correctness of our codebase. Test cases for critical functions such as loan cost calculations, user authentication, and user input validation have already been written. The plan is to continue expanding the test suite as our application evolves, ensuring robust and reliable code.

Additionally, our subscription request to Citizens' internal "Accounts" API was approved during this sprint. This approval now allows us to fetch Citizens bank user account information and display it on our dashboard. As a result, we successfully completed the user story of allowing users to connect their Citizens Bank account within our WPI dashboard. This integration enhances the user experience and sets the stage for further functionality. We also dedicated time to researching ways to modernize and simplify our dashboard. Our goal is to create an intuitive and clutter-free design. While this was not an implementation sprint for UI changes, the research conducted lays the groundwork for future enhancements to optimize user interaction.

With the successful deployment and integration, we are well-positioned to continue development in the upcoming sprints. The focus will be on expanding functionality, writing additional test cases, and incorporating UI improvements based on the research conducted.

### 6.5.1 Sprint 4 Retrospective

This was a pivotal week for the team. A large blocker facing the team over various sprints was deploying the application to Citizens' pipeline. Due to successful communication with the software engineers on the team, significant changes were made to the application structure, allowing the app to be deployed containing all code and functionality. Once this was completed the team shifted focus to modernizing and modifying the UI. While at Citizens campus, the team discussed with Jeff and Glenn the direction of the UI for the dashboard. In

person visits continue to work well for the team, as it provides the team with great access to resources. Furthermore, after many iterations on a whiteboard, the new look of the dashboard was created. While all functionality of the dashboard remained unchanged, the dashboard's interface is now simpler. Emphasis was placed on making payments, applying for a loan and the total bill amount, as these are the key needs of the user.

## 6.6 Sprint 5

Points	User Story	Type	Status
1	Display account owner name in dashboard	Story	Done
1	Financial Aid Offers	Story	Done
5	Loan Repayment Visualization	Story	Done
1	Modify capstone presentation	Story	Done

Table 11: Sprint 5 User Epics and Stories

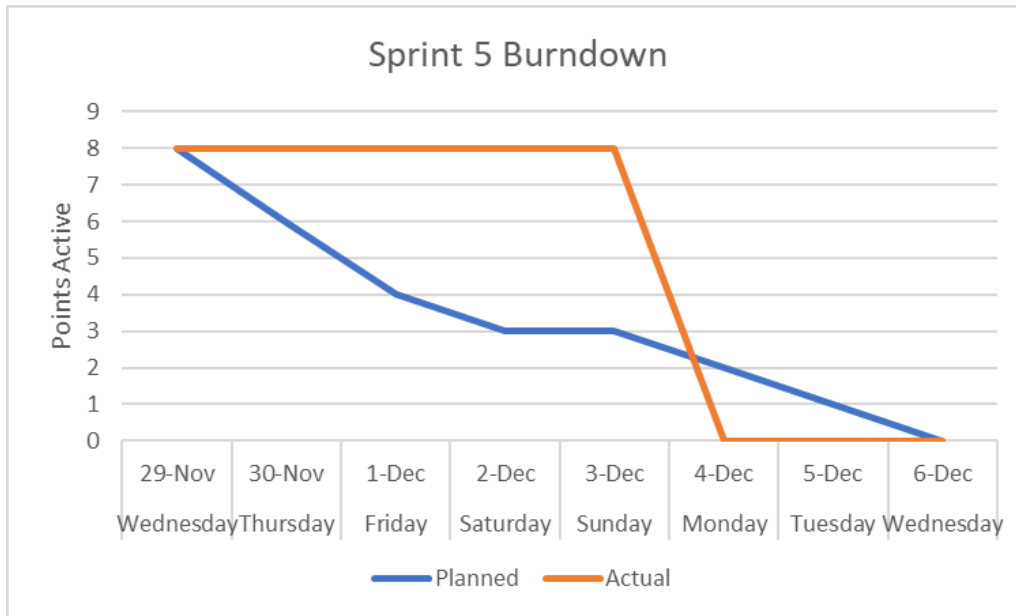


Figure 18: Sprint 5 Burndown Chart

Total Points Completed: 8

Throughout this sprint, the team dedicated efforts to prioritize tasks such as modifying the UI, expanding functionality, and iterating on the dashboard for the upcoming capstone presentation scheduled on December 7th. Although the initial dashboard encompassed most functionalities, the primary focus was to revamp it for a more user-friendly experience. In pursuit of creating a more streamlined user interface, a new dashboard was developed. This updated interface presents fewer elements compared to the previous version, aiming for a decluttered/ simpler look. Its primary objective is to spotlight essential user information, like the bill amount, linking Citizens Bank accounts, and applying/managing open loans. All the previous dashboard information remains intact but has been relocated under their corresponding section, enabling users to access it as needed. Notably, the new dashboard prominently features a section displaying active loans, showcasing their duration, remaining amount, and monthly payments in a straightforward layout.



While designing the new dashboard, much of the existing functionality was retained. For instance, the bill section still includes a dropdown menu for college-related expenses, now arranged vertically for a more simplified presentation. Moreover, information on current loan rates has been repositioned under a new segment labeled "Student Financial Links." The available funds section retains its functionality but now showcases larger font size for enhanced readability, considering its significance. Loan rates play a critical piece in determining the cost of loan repayment and it should be noted that due to time constraints the team was unable to add all necessary calculations to determine individual loan rates. Due to this, credit score was the only factor taken into account when calculating a user's rates. While this was too difficult for the scope of the project, it also served to assure all test users were assigned a loan for simplicity of the application. However, in the future all necessary information behind calculating rates would have to be taken into account.

An integral part of the project involves the upcoming Citizens Bank internal capstone presentation. The team has prepared to present the value proposition, conduct a live demonstration of logging in and applying for a loan, share key insights, and outline future expectations to the management team. These preparations have involved substantial efforts in refining presentation skills in anticipation of the in-person presentation at Citizens campus, a focal point of this sprint's activities.

### 6.6.1 Sprint 5 Retrospective

The team's ability to cultivate a dynamic, high-achieving atmosphere is supported by effective communication and backing from Citizens Bank. Throughout the initial sprint of this project, all tasks were finished two days ahead of schedule. Collaborating with the bank

representatives and WPI advisors enabled the team to pinpoint essential dashboard functionalities, resulting in the creation of an exciting product.

During this sprint, there were no obstacles encountered, showcasing the team's seamless collaboration. Visits to the Citizens campus facilitated bonding opportunities during commutes and expanded the team's network within the organization. The team attributes its ongoing success to consistent and efficient communication practices, including numerous rehearsal presentations leading up to the capstone, fostering a confident environment.

As the team approached the final sprint, the team was assured of meeting project deadlines while delivering a high-quality application. Final adjustments to the dashboard were underway, leaving only minor UI refinements, such as font color and appearance, for the last sprint. This strategy allowed the team to allocate time towards any unforeseen modifications that might have arisen.

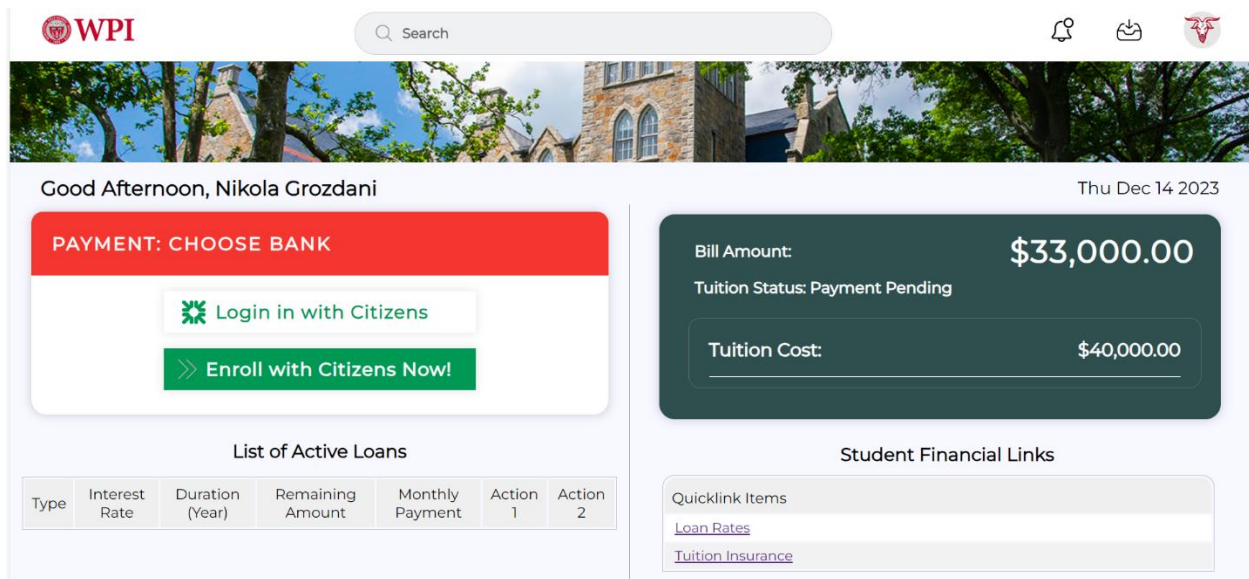


Figure 19: Final Dashboard

## 6.7 Sprint 6

Points	User Story	Type	Status
1	Iterate Dashboard	Story	Done
1	Send academic report to the bank	Story	Done

Table 12: Sprint 6 User Epics and Stories

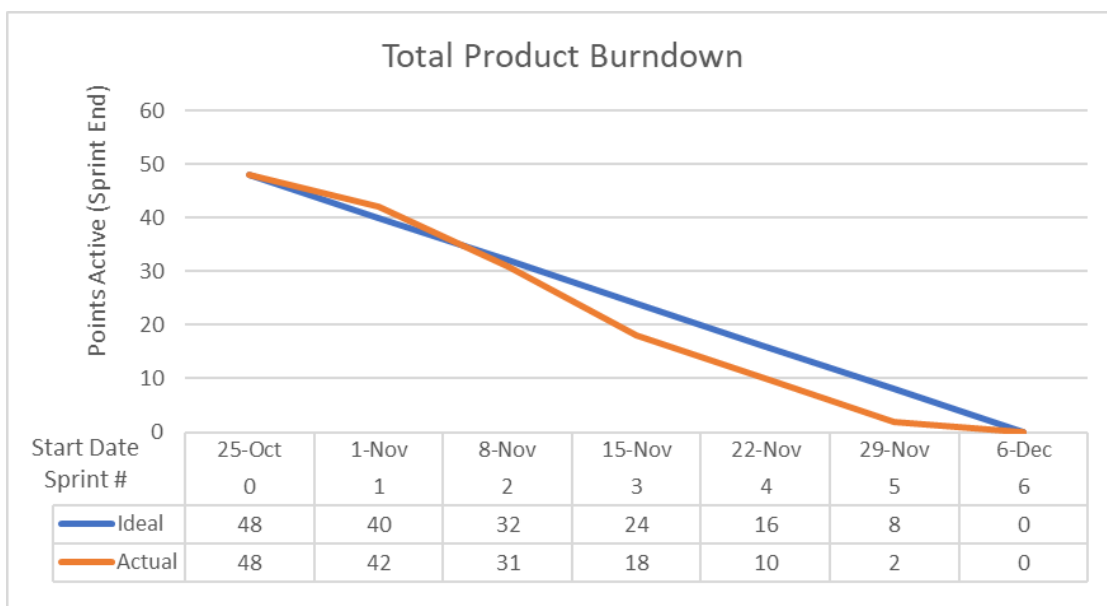


Figure 20: Total Product Burndown Chart

### Total Points: 2

During the last sprint, the team completed two crucial remaining elements of the project: the dashboard and the report. Iterations to the dashboard included small but impactful visualizations aimed at enhancing the overall UI. These payment visualizations were added in the process of applying for a loan. The simple pie chart shows users a percentage of principal versus interest in the total repayment total. This enhancement allows users to easily visualize their payments.

Effort was also directed towards completing the report and sending it to Citizens Bank. Through several iterative processes, the team fine-tuned every aspect, ensuring its accuracy, completeness, and readability. The iterative improvements encompassed content organization and visual clarity, culminating in a comprehensive and polished final report.

After timely completion of both of the remaining elements, the team had completed all remaining work for the project. The efforts throughout this sprint fortified our deliverables and also contributed significantly to the overall success of our project, setting a solid foundation for future endeavors.

### 6.7.1 Sprint 6 Retrospective

The high achieving atmosphere and successful communication that was established through the previous six sprints allowed the team to complete all stories in an effective manner. Additionally, the capstone presentation served as a great opportunity to showcase work that has been completed over the last seven weeks to a number of full-time Citizens Bank employees. The team is grateful for all the opportunity to have built upon the relationship between Citizens Bank and WPI and for all the help received throughout the course of the project.

# 7. Business and Project Risk Management

## 7.1 Risk Mitigation

Within the financial services and banking industry the protection of sensitive information is of utmost importance. The team experienced this firsthand from the start of the project. Citizens Bank has multiple layers of protection in order to prevent sensitive information from becoming leaked. Due to the size of the bank, there are many organization wide security protocols in place to satisfy corporate and industry regulation. In the beginning of the project one team member faced VPN issues, as Citizens only allowed a specified number of attempts before freezing an account for security reasons. Another example of this was gaining access to Citizens' pipeline and technology stack. The team was exposed to corporate timelines, and this presented complications due to tight deadlines. In order to maintain strict security surrounding Citizens Bank, our team had to be provisioned access to the technology stack and internal information.

Due to the nature of the industry and to meet compliance, Citizens Bank was unable to provide access to personal information to use in our application. Our application aims to provide checking and savings account information when logged in to the Citizens account, however there are many compliance risks associated with this level of personal information. For this reason, our application pulls from APIs that pull mock information. It was delivered to our group that this is necessary to stay within the confines of customer data protection policies.

As a third party, contracted extension of the Frontier Pod, the group and Citizens Bank inherently took on operational risk when onboarding and bringing on our team. It was expected and explicitly stated that we are responsible for managing our own risk. If we failed to manage it during the project, Citizens Bank would then assume the risk.

Citizens Bank understands the potential compliance, operational, strategic, technology, financial crime and reputational risk when sponsoring our team. It was understood that the team had to adhere to strict guidelines set in place internally at Citizens Bank to manage risk. Within this industry, risk tolerance is extremely low, and the bank understands the potential reputational risks if the guidelines are not adhered to. Reputation is paramount in a highly regulated industry and as internal contractors at the bank, there was potential for risk.

## 7.2 Compliance Risk

The employees of Citizens Bank must adhere to internal policies and regulatory standards. Similarly, the team was required to uphold specific codes of conduct and ethical guidelines. Consequently, the team was restricted from accessing personal customer data for our application. Instead, the team utilized internal test checking account APIs that lacked personal information. It is important to note that this data is confidential and personal, and using it would have breached customer data protection protocols.

## 7.3 Operational Risk

As Citizens Bank engaged our group as a third-party entity, there existed the potential for operational risk for the bank. It was incumbent that the team independently manages risks and fulfills the necessary regulatory and corporate governance standards. Failure to meet these standards would have resulted in Citizens Bank assuming these risks. Additionally, another operational risk the bank might have faced was related to talent and skill sets. This risk could have materialized if there was a lapse in ensuring adequate talent and skill sets among the employees involved.

## 7.4 Strategic Risk

At a large highly structured organization, strategic risk might arise from either inadequate governance or deficient strategic planning. If the sponsor's guidance was lacking in defining the group's expectations or if there was a dearth of direction in the project's vision, it would significantly affect the group's operational value. Inadequate governance and oversight within a group pose substantial risks and create vulnerabilities, ultimately transforming into internal limitations that could impact the group's performance.

## 7.5 Technology Risk

The largest risk and bottleneck we faced as a group throughout our time at Citizens Bank was related to technology risk. Due to the time constraints, the seven-week project forced tight deadlines. Inadequate access to the technology infrastructure set our group back multiple times. There were numerous occasions where we had to wait to be provisioned access to certain applications necessary to move forward in development. In large part, this was due to the high security constraints set in place entity-wide within the bank. With a normal corporate schedule, this would not pose any issues, but because of the fast-paced environment of the project, this set us back at times. The main inconvenience came from being unable to get on the Citizens pipeline for the first few sprints. This caused time deficiencies and accessibility issues for the developers.

## 7.6 Financial Crime

In the tightly regulated banking sector, every team within Citizens Bank is linked to the risk of financial crime. Accessing personal data or infrastructure within the bank could pose

potential risks. The bank employs stringent information security measures and regulatory protocols to prevent unauthorized access, disruptions, alterations, or loss of specific data.

Citizens Bank assumes risks associated with our team if we neglect to identify and prioritize our cyber vulnerability management. In the risk-averse banking industry, our team was not granted internal authorization to access personal data or information as a precautionary measure.

## 7.7 Reputational Risk

Finally, by collaborating with our team, Citizens Bank encounters external reputational risks. Reputational risk encompasses potential harm to the bank's image due to unpopular business decisions, strategic directions, or perceived failures in commitment to social and environmental sustainability. This risk can emanate internally from employees or externally from customers and investors.

Given our team's contractual association with Citizens Bank, the associated risks lean toward internal aspects. If a team member experiences dissatisfaction during their tenure at the bank, it poses a risk of low employee satisfaction. Moreover, as both bank employees and team members are linked to the bank's image, their actions may impact the bank's reputation, positively or negatively, wherever they go.



## 8. Assessment and Retrospective

The goal of the project was set in place during PQP in A-term. This allowed the team to begin working on the deliverable immediately after being onboarded. However, the scope was redefined multiple times throughout many iterations. From a high level, the goal is to embed Citizens' capabilities into a simple dashboard that allows WPI students to link their bank accounts through Citizens Bank, in turn making payments for the cost of tuition, or applying for a loan if needed. This would be considerably easier than the current process in place of using multiple third-party services.

### 8.1 Team Learnings

#### 8.1.1 Andrei's Learnings

After experiencing what it was like working on a scrum team of ten students during WPI's Software Engineering course, it was difficult to adjust to working within a whole division of a corporation as a sub-team of three people. Learning how to navigate the corporation's systems regarding onboarding, API access, and building pipelines was a significant challenge for me and my team. Overall, working with the team to develop an idea of the product that we wanted to deliver, and constructing a tech stack that satisfied the non-functional requirements was important, yet we encountered difficulties. I understood well how important initial designs, knowledge of tech environments, and example projects to refer to during development were to the progress that we made. However, in a corporate software development system, these things become way more significant and the time saved compounds.

At the start of the project, I had little familiarity with front-end web development, making it very difficult to quickly implement functionality. Referring to the previous project team's code and online tutorials greatly sped up my learning process. I was also unfamiliar with CI/CD protocols. The learning curves of these softwares stalled my work, but this is simply a problem that is fixed with time and experience. It is better to work with a familiar system than one that may be more comprehensive but unknown. Sometimes this cannot be avoided, as the specifications of the project and corporation require these to be used.

The truth is that delays, blockers, and lack of experience can make development take longer than expected. My takeaway is that preparing for the worst-case scenario and expecting the unexpected is a wise decision in projects like these. There are reasons why Agile Methodology is structured the way it is: to be able to adapt and address these roadblocks as quickly as possible, within a team of people with different skills and backgrounds. Although our team communicated well and delivered on our promises consistently, there were some inevitable problems that we ran into and learned to overcome.

### 8.1.2 Nikola's Learnings

My engagement with the Citizens team on this project has been an invaluable experience that has provided me with great insights into the dynamics of corporate software development. Collaborating with fellow software engineers has not only improved my technical skills but has also exposed me to the challenges of adhering to strict protocols, a characteristic hallmark of the corporate world. Our team learned this at the initial start of the project when we realized that the newest node version we had installed was not yet compatible with Citizens' internal systems and software pipeline. This required us to take a multitude of different steps, some of which involved getting access to admin credentials in order to successfully handle this version discrepancy. I

learned that even though the latest software versions have their own unique perks and advantages, they are not always the safest and typically the least tested, which is why the bank is careful about using them.

Regular communication with Citizens' sponsors to delve into the project's requirements and design specifications has given me an inside perspective on the challenges of transforming an idea into reality. I have gained insights into the refined process of crafting solutions that offer mutual benefits to all stakeholders, in this case, Citizens and WPI. I also had the opportunity to learn about how the Citizens team applies Agile methodologies to enhance their work efficiency. Being a part of their daily operations, I actively participated in various Agile practices such as daily scrum meetings, sprint planning sessions, backlog grooming, retrospectives, and demo meetings. These sessions were crucial in understanding how the team organizes their work, prioritizes tasks, and ensures continuous improvement throughout the project. In addition, through frequent conversations with the sponsors, I gained valuable insights into the significance of simplicity in UI/UX design. Users usually do not care about how the different parts of the app work internally. What matters most to them is whether they can easily do what they want in the app. Our sponsors stressed that users prefer straightforward designs that let them navigate the app without confusion. They do not want too much detail that might make things complicated. It is better for the app to quickly get to the point and focus on what users need to do. These observations guided my approach to creating solutions for the project, emphasizing the importance of making the app easy to use and efficient for the users.

Throughout the project's development, I have familiarized myself with various web development tools and frameworks, notably Next.js, employing a React front-end and server-side rendering backend. This experience familiarized me with the development of full-stack web

applications, shedding light on the concept of state management, the process of maintaining knowledge of an application's inputs across multiple related data flows. I also got to delve into the crucial domain of CI/CD deployment protocols, essential to Citizens' pipeline. This provided me with a comprehensive understanding of CI/CD practices and their vital role in streamlining the software development lifecycle, with a focus on key tools such as Jenkins, OpenShift, and Docker. Before this project, I had limited familiarity with CI/CD deployment practices, making this exploration a significant learning experience for me.

### 8.1.3 Zach's Learnings

This project provided me with a multitude of new learnings, teachings, and experiences. Working as a Product Owner and being exposed to Agile methodologies was a relatively new experience and provided initial challenges. However, as I went through the onboarding process, continued to sit in on/take place in Team Frontier ceremonies and spent time learning Citizens Banks processes I quickly became adjusted. Coming from a business and finance background, I had little experience in development besides taking one course at school. Despite not acting as a developer, I find myself much more comfortable when delivering updates to the team on the development work that was completed. Specifically, when it came to learning about the different databases that were used to develop our web application.

Working internally with the team at Citizens Bank allowed us the opportunity to learn from full-time employees in the industry. Due to this, I found myself learning much more about Jira's capabilities during my time as a Product Owner than I did as a student during the course of the PQP. Additionally, by working internally and acting as employees of the bank, I found it as if the team began to communicate more effectively as the project went on. The corporate language

used is vastly different from an academic setting and this project provided many opportunities to learn the language of the industry.

## 8.2 Business Learnings

Having the privilege of being sponsored by Citizens Bank proved to be an invaluable experience for every team member. Our stint as full-time employees granted us insight into the inner mechanisms of a large corporate setting. The team also experienced how large scale meetings were run and organized across various business units and locations. This was evident in the final capstone presentation, which was attended by sixty full-time employees, providing the team with an invaluable experience in how to clearly and concisely deliver an update in a highly regulated corporate environment. Citizens Bank is known in the industry for its collaborative culture, and robust leadership structure and commitment to driving the bank forward through innovation and customer-centric approaches

### 8.2.1 Citizens Bank Culture

Citizens Bank, a leader in the banking sector, earns esteem for its leadership and collaborative culture. Renowned for innovation, the bank prides itself on fostering collaboration. Despite our role as temporary contractors, the team received equal treatment, even participating in full-time employee ceremonies. Throughout our tenure at Citizens, a recurring question and learning point was, "How does this generate revenue?" This served as a bridge between our business and technical knowledge, aligning with our focus on delivering value to customers. The team realized that to provide value to customers, understanding their interest lay not in the application processes but in how it benefited them. The application imparted invaluable lessons.

Numerous UI iterations taught us that simplicity is paramount. Users tend to read dashboards from left to right, prompting us to research industry-standard dashboards and tailor ours for maximum user-friendliness. Vital information occupies the top in large font, offering users clear choices like "make a payment" and "apply for a loan" to eliminate confusion.

## 8.2.2 Citizens Bank Leadership

This experience, similar to an internship, provided team members the opportunity to carry forward numerous invaluable lessons to their future endeavors. Being treated as full-time employees, attending diverse meetings, and in-person team visits equipped us with the skills to navigate within a large corporation. Notably, learning corporate meeting etiquette and delivering value during such occasions is among the skills the team eagerly anticipates employing in their future pursuits. Leadership at Citizens Bank has emphasized a customer-first approach, aiming to enhance customer experiences through technological advancements, personalized services, and a wide array of financial products. Innovation and digital transformation have been key focal points under the bank's leadership, with efforts directed towards improving online and mobile banking platforms to cater to the evolving needs of customers. Our team was able to witness leadership on a daily basis when our sponsors would address their team. All ceremonies were driven by collaboration, innovation and a customer-first approach.

## 8.3 Technical Learnings

### 8.3.1 Balancing Stability and Functionality

In our pursuit of leveraging the latest software perks, our team initially opted for Node.js version 18. However, we quickly learned that the newest code often represents untested software,

leading to potential stability issues. Discovering Citizens Bank's preference for Node.js versions 16 and earlier prompted a strategic shift in our approach. Aligning our technology stack with the organization's deployment requirements became a priority, highlighting the importance of early and thorough technology stack evaluations. Transitioning to an older Node.js version, though initially cumbersome, showcased the team's adaptability. Overcoming administrative access credential challenges became a valuable lesson in navigating unforeseen hurdles and adapting to the specific requirements of the corporate environment. Working within Citizens' environment underscored the importance of stability over bleeding-edge functionality. Our experience highlighted that organizations mitigate risks effectively by favoring stable, well-established software over the allure of the latest technologies. This realization became a cornerstone for future decision-making, emphasizing the need to strike a balance between innovation and reliability.

### 8.3.2 Deploy First, Code Later

During the first three weeks of the project, we confined all development activities to a web application that operated locally on our computers. This limitation stemmed from the fact that introducing a new application into Citizen's pipeline required alterations to deployment configuration files within the bank's internal 'deployment-config' repository on Bitbucket. Our team submitted a pull request to the repository, incorporating the essential modifications required for our application to deploy, and awaited approval. The approval process was lengthy, necessitating authorization from multiple senior engineers and requiring at least two successful internal builds with the proposed changes before advancing to the master branch of the repository. Once approval was obtained, a new challenge emerged: our application failed to deploy due to a dependency/binary required for Prisma being blocked by Citizens' private

network (*Prisma*, n.d.-b). This happened because Prisma recompiled the query engine necessary to interact with the database file by default whenever the app was rebuilt, necessitating the retrieval of binaries from an external source. Despite close communication with software engineers from the Frontier Pod and numerous attempts to address the network security issue, our application remained blocked from deployment. At the suggestion of Citizens' sponsors, we opted to abandon Prisma and explore Sequelize (ORM), which was compatible with Citizen's pipeline (*Sequelize*, n.d.). However, Sequelize posed a challenge as it required a separate installation of our in-memory database SQLite3, which was blocked by Citizen's network. After presenting alternative options to Citizen sponsors, we received a recommendation to consider MongoDB as an in-memory server database. However, uncertainties surrounding its support on PaaS led us to decide against adopting it (Chai et al., 2022). Given the time invested in the project and the substantial effort required to change the ORM/database, the team opted to devise a workaround for Prisma. This involved keeping a pre-built Prisma query engine within the application's files. Since the structure of the database usually would not change between deployments, this engine would work for many separate builds of the application, optimizing Prisma's initialization and resource demands. This innovative approach successfully resolved the deployment issue, marking a significant milestone for the team and enabling us to resume the development of our application. The experience underscored the importance of validating software compatibility in a corporate environment before incorporating it into development. It also emphasized the need to address such issues early in the process, avoiding deployment until the application is successfully integrated into the pipeline.



### 8.3.3 Operational Adaptation in a Corporate Environment

Our team quickly recognized the significance of enterprise tools such as Jenkins, Bitbucket, and OpenShift within the corporate framework of Citizens Bank. Integrating these tools into our development workflow proved essential for streamlining processes and ensuring consistency. Understanding the nuances of each tool became imperative, and our learning curve involved mastering the intricacies of configuration and optimization. Operating within a large organization like Citizens Bank necessitated adapting our communication styles to fit the unique needs of various teams. The challenge of preventing requests from going unanswered led us to establish robust communication protocols. Regular follow-ups became second nature, ensuring that we received the necessary responses in a timely manner and maintaining the momentum of our development efforts.

## 9. Future Work

### 9.1 Embedded Finance for Colleges

Advancing embedded payment systems in college financing requires taking a look at how financial data and academic data (or data from any private institution) can be securely exchanged. Our application was an example of how to bring to students all the information that they need to make a decision such as their tuition costs and means of financing. Integrating data from other college expenses like housing, dining, campus store, and textbooks could be the next opportunity for embedded finance to make students' college finances more transparent and efficient. The challenge of presenting all of this information to the student is making the embedded payments informative to the student while still keeping it simple.

The difficulty of integrating all of the necessary data may be the reason that college finance and service portal's like WPI's are so fragmented. Finding a way to combine different college transactions in one application can be daunting, but overall useful to the students. Since college and all of its additional costs are quite large expenses, students should know what they are purchasing and how to go about it. Optimizing the purchasing decisions can speed up transactions and save time for students. Student loans, of course, can lead to a student finding a bank to borrow with over the long term. Overall, there is a lot of benefit for both the financial sector, colleges, and students if more work is done in this field.

### 9.2 Financial Visualization

The math behind the rates of loan repayments may greatly benefit the borrower, such as the selected term and type, yet they could be misinformed. Graphs of loan repayments showing

how much of the principal and interest they are paying every month may encourage borrowers to pay off their principal earlier to avoid interest. Looking into how users respond to different financial visualizations and how their understanding of the concepts behind their finances could improve the optimization of user interfaces regarding finance. It is important to study the user experience throughout banking apps and other financial portals to see where users lack understanding.

Embedded finance is extending past just instant payments. Embedded lending, investing, and insurance are much more complex and nuanced systems. For the user to have the best experience, they should have visualizations at their disposal to make a multiple-factor decision, even if they are new to the financial jargon and math. Visualizations of stock options, trade volumes, loans, and insurance options could help make up for a lack of experience. Lowering the barrier to entry of finance apps can greatly incentivise users to be more confident in their finances, and more confident in choosing their bank or trading platform.

## 10. Conclusion

As a company interested in advancements in fintech, Citizens Bank worked towards implementing embedded financial capabilities to better provide services to colleges and their students. Worcester Polytechnic Institute's financial portal, like many college tuition portals, often required a student to navigate between multiple sites to pay their tuition, view financial aid awards, and explore loan options. The prototype portal accomplished this by containing all necessary financial needs, thus being a simpler and more convenient solution to the current fragmented dashboard offered. This effort aimed to show how to improve college students' user experiences when making financial decisions. Additionally, the benefit of this project to Citizens Bank was the opportunity to forge fresh ties with Citizens Bank, with the goal of securing extended borrowing options at the institution, while concurrently fostering and reinforcing relationships with current customers.

The culmination of Team Scholar's efforts throughout the project's multiple iterations has resulted in the successful development and implementation of a user-friendly financial portal for Citizens Bank. From the beginning, the team set a clear goal: to embed Citizens' financial services directly into WPI's student portal. This objective aimed to simplify the process of making tuition payments and applying for loans, eliminating the need to navigate to third-party applications. Now, this goal has been achieved with a dashboard that surpasses the efficiency of WPI's existing system. The newly implemented dashboard enables students to effortlessly connect their Citizens bank accounts directly through the portal, eliminating the need to navigate through various third-party services for managing tuition, payments, and loans. In developing this advanced dashboard, we utilized a suite of tools, including Visual Studio Code (VSCode) for coding and collaboration, BitBucket for source code management, and Docker, Jenkins, and

OpenShift for automation and deployment. These tools were instrumental in handling deployment processes and played a vital role in containerizing the application. The 2023 team's dashboard signifies a significant leap toward the modernization of college-related expense management, marking a noteworthy achievement in our ongoing commitment to enhancing student experiences.

The partnership between Citizens Bank and WPI established through this project is set to deliver mutual benefits to both institutions. Specifically, by enabling students to establish new connections with Citizens Bank, the goal was to secure expanded borrowing at Citizens Bank while concurrently fostering and reinforcing relationships with its current customer base. The team feels satisfied with the significant progress accomplished and the collaboration established with Team Frontier. The technological framework, incorporating BitBucket, Jenkins, OpenShift, Docker, Postman, and Jest, proved crucial. These tools enabled smooth collaboration, automation, deployment, containerization, testing, and guaranteed a robust, error-free solution. The application developed during this project not only contributes to the ongoing modernization of student payment methods but also holds the potential for broader applications within the areas of education and financial technology.

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# Appendix

## A. Interface Screenshots

WPI Search

Good Afternoon, Nikola Grozdani Thu Dec 14 2023

**PAYMENT: CHOOSE BANK**

Login in with Citizens

Enroll with Citizens Now!

List of Active Loans

Type	Interest Rate	Duration (Year)	Remaining Amount	Monthly Payment	Action 1	Action 2
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Student Financial Links

Quicklink Items

- [Loan Rates](#)
- [Tuition Insurance](#)

Dashboard on Login

WPI Search

Good Afternoon, Nikola Grozdani Thu Dec 14 2023

**PAYMENT: CHOOSE BANK**

Login in with Citizens

Enroll with Citizens Now!

List of Active Loans

Type	Interest Rate	Duration (Year)	Remaining Amount	Monthly Payment	Action 1	Action 2
------	---------------	-----------------	------------------	-----------------	----------	----------

Student Financial Links

Quicklink Items

- [Loan Rates](#)
- [Tuition Insurance](#)

Bill Amount: **\$33,000.00**

Tuition Status: Payment Pending

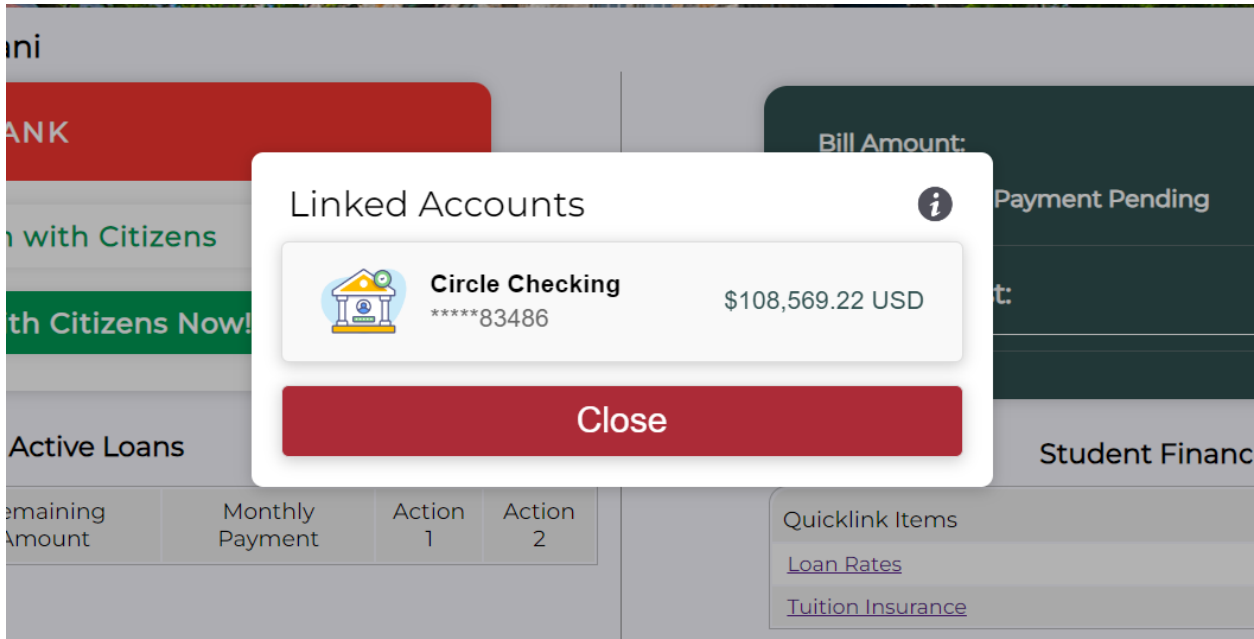
Tuition Cost: **\$40,000.00**

- Undergraduate Courses: \$29,000.00
- Housing: \$4,500.00
- Meal Plan: \$3,000.00
- Health Insurance: \$2,750.00
- Wellness Fee: \$450.00
- Student Living Fee: \$300.00

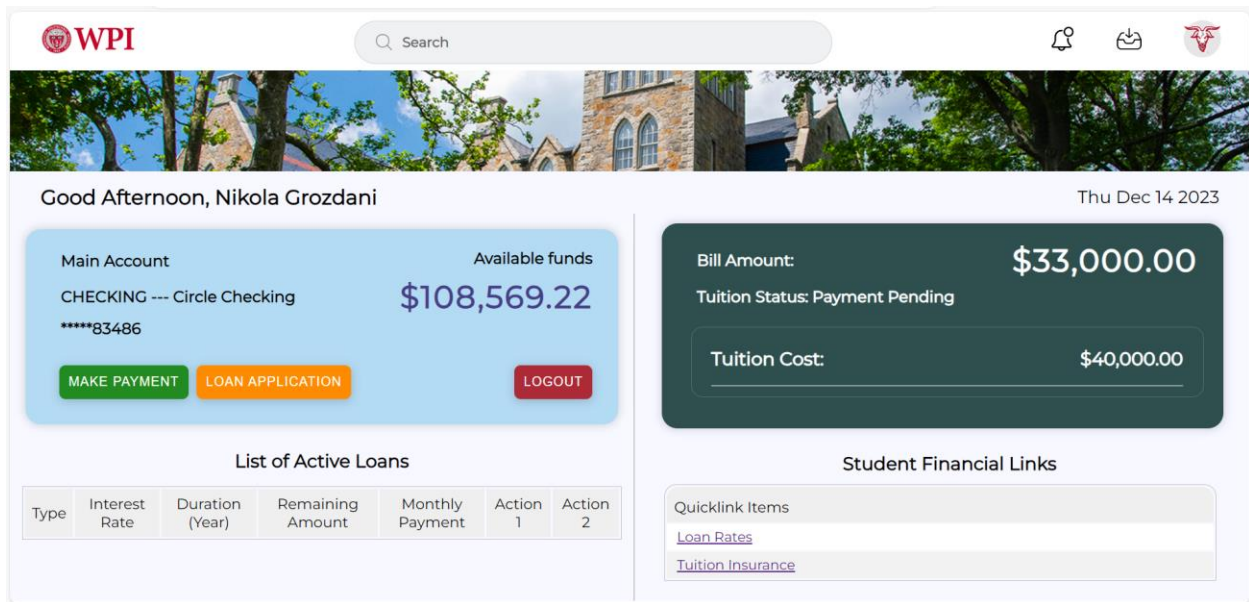
Financial Aid: **\$7,000.00**

- Scholarships: \$7,000.00

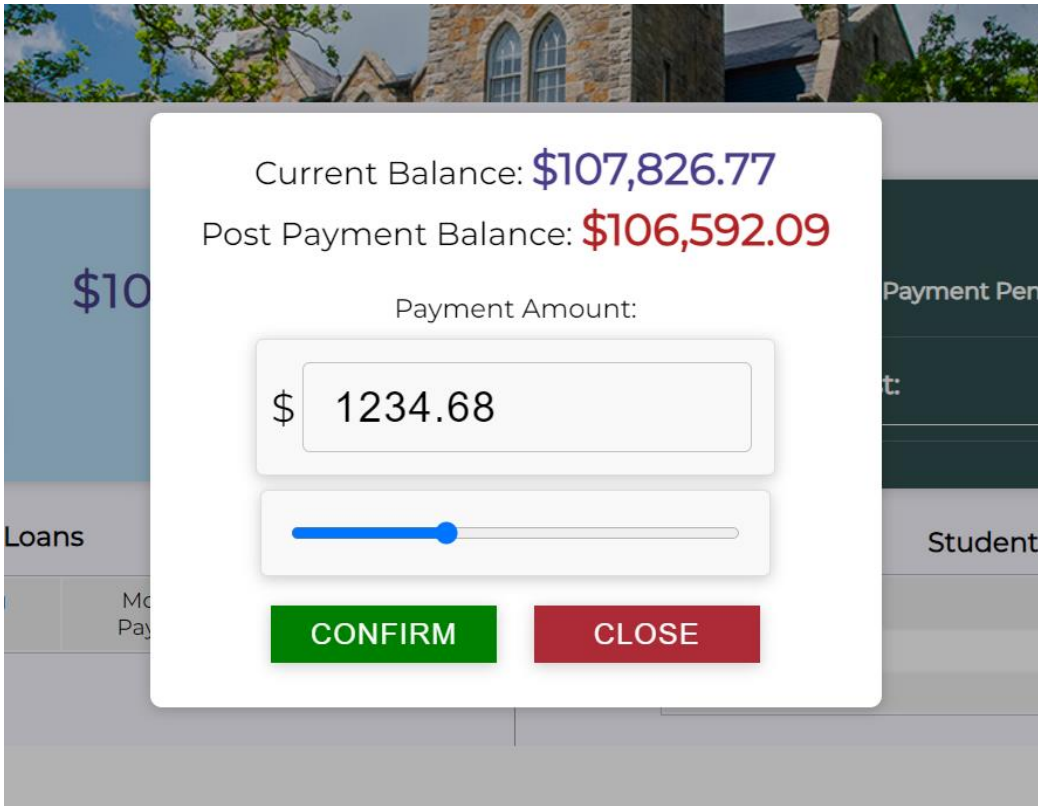
Dashboard with Tuition and Financial Aid Statement Expanded



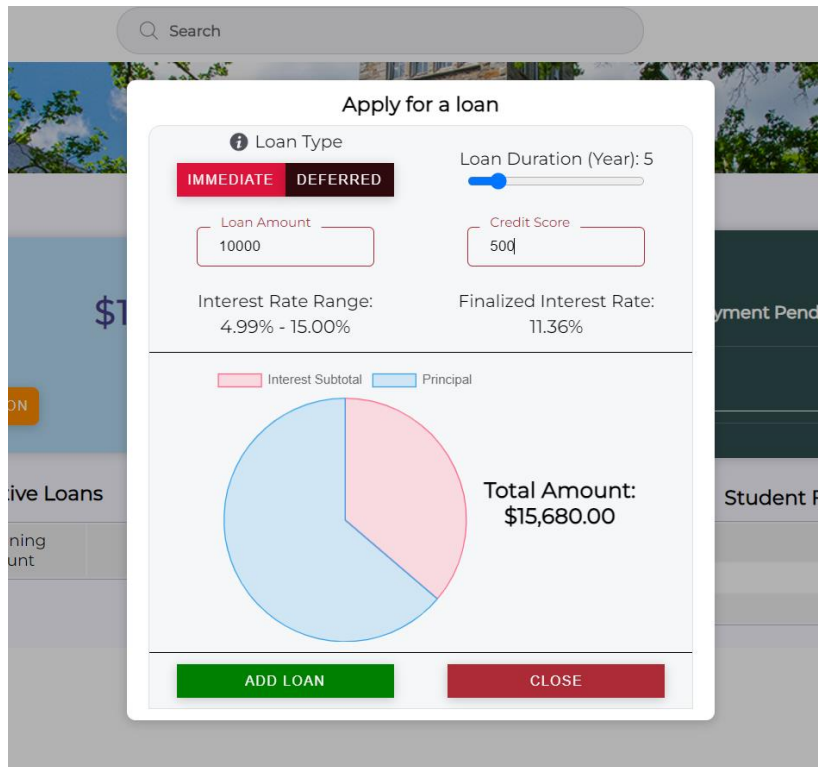
Account Linking Popup



Dashboard with Bank Account Linked



Tuition Payment Popup



## Loan Application Popup

### Loan Confirmation

- You are applying for a *Immediate* loan at a fixed rate of **11.36%**.
- The payments will start *immediately* and your first month's payment will be **\$261.33**.
- If payments arrive as expected, the loan will take **5 years** to pay off.

CONFIRM LOAN
CANCEL

## Loan Application Confirmation Popup



Good Afternoon, Nikola Grozdani

Main Account

CHECKING --- Circle Checking

\*\*\*\*\*83486

Available funds

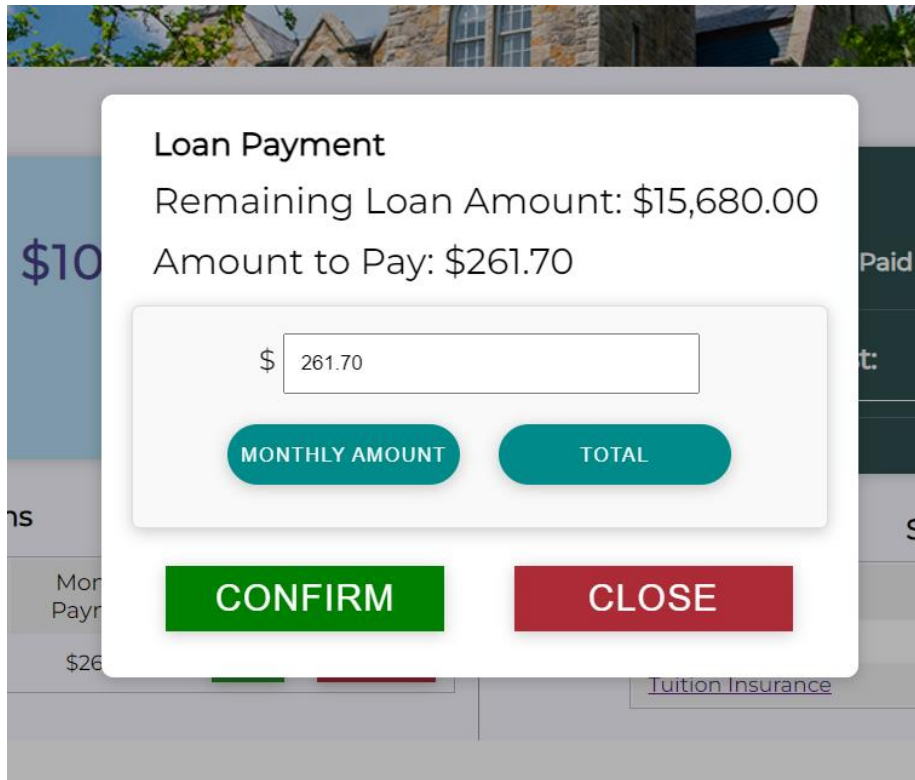
**\$109,015.22**

MAKE PAYMENT
LOAN APPLICATION
LOGOUT

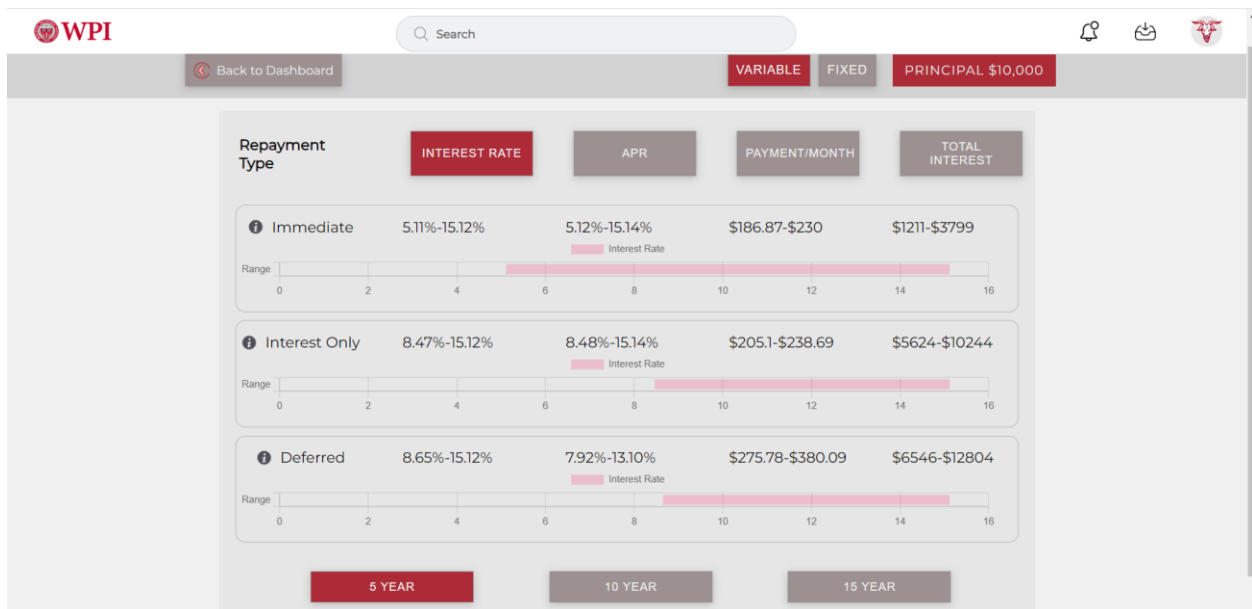
### List of Active Loans

Type	Interest Rate	Duration (Year)	Remaining Amount	Monthly Payment	Action 1	Action 2
Immediate	8.10%	5	\$9,835.00	\$163.92	<span style="background-color: #28a745; color: white; padding: 2px 5px;">PAY</span>	<span style="background-color: #dc3545; color: white; padding: 2px 5px;">REMOVE</span>

## Loan Table with Active Loan



Loan Payment Popup



Loan Rate Comparison Screen