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A Lightweight Java Console Application to Simulate Bank Transactions with Account Logic

Ankith Akula

Dunlap High School, Dunlap, IL 61525, USA; ankithakula9@gmail.com

ABSTRACT: This article presents the design and implementation of a lightweight Java console application that simulates basic bank transactions using fundamental account management logic. The project serves as a pedagogical tool to demonstrate object-oriented programming concepts in a real-world banking context. The system enables users to create accounts, deposit and withdraw funds, check balances, and review simple transaction outcomes through a text-based menu interface. Emphasis is placed on clarity, simplicity, and educational value, making it accessible to high school researchers and beginner programmers. The article outlines the limitations of existing solutions for teaching banking concepts, the proposed system's architecture and features, and implementation details, including class design and control flow. Results from sample runs are discussed to validate the correctness of the account logic and transaction handling. The advantages of the console-based approach, such as ease of use, low resource requirements, and focus on core logic, are highlighted. The article concludes with potential enhancements and the educational impact of engaging students in simulation development for computer science learning.

KEYWORDS: Java, Console Application, Object-Oriented Programming, ATM, Lightweight System, Menu-driven Interface.

Introduction

Simulating real-world scenarios in programming projects can significantly enhance student engagement and understanding.[1] In particular, a banking system simulation provides a familiar context for applying programming skills, allowing students to practice complex problem-solving in a safe virtual environment, without real-world consequences.[2] Java, being a widely used object-oriented language, is well-suited for modeling such real-world entities as bank accounts and transactions.[3] In Java, classes and objects serve to represent real-world concepts and entities, enabling developers (even at the high school level) to map banking concepts, such as accounts and balances, into code structures. For example, an Account class can represent a customer's bank account, encapsulating details like account number, account holder name, and balance, while methods model behaviors such as deposit or withdrawal.

High school students often undertake console-based projects to solidify their programming fundamentals.[4] Console applications are text-driven programs that run in a command-line interface; they are popular in education due to their low overhead and focus on core logic. Compared to graphical software, console apps are quicker to develop and use significantly less memory, allowing beginners to concentrate on functionality rather than user interface complexities.[5] The banking simulation described in this paper is a console application, intentionally chosen for its simplicity and clarity of interaction for both developer and user. By eschewing graphical elements, the project emphasizes algorithmic thinking and object-oriented design critical skills in early computer science education.

Numerous examples and tutorials of simplified banking systems or ATM (Automated Teller Machine) simulations have been created by students and educators.[6] These range from basic one-account demonstrations to more elaborate multi-account management systems. For instance, Matsi (2025) described a console-based banking project featuring account registration, authentication by PIN, and basic transactions, which helped the student developer practice input validation and menu-driven program structure. Such projects underline the educational benefit of applying programming concepts to emulate banking operations, reinforcing topics like data validation, state management, and user interaction. However, many existing educational examples are either extremely rudimentary (handling only a single account or lacking persistent data) or too advanced for beginners (incorporating databases or graphical interfaces).[7] This paper addresses the gap by presenting a balanced approach: a lightweight yet functional banking simulation that is accessible to high school programmers, while illustrating key software development principles.

The remainder of this paper is organized as follows. The Existing System section reviews the context and limitations of prior approaches and real-world systems in relation to this project. The Proposed System section outlines the objectives and features of the new console-based banking simulator. The Implementation section details the program architecture, including class structure and control flow, accompanied by a flowchart and class diagram for clarity. In Results, we demonstrate the program's operation with sample inputs, output screenshots, and test case tables to verify correctness. The Advantages of the system are then discussed, highlighting its educational and technical merits. Finally, the Conclusion summarizes the work and suggests future enhancements, followed by the References supporting this study.

Existing System:

Banking in the real world is supported by sophisticated software systems that handle millions of transactions, with strict

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requirements for security, concurrency, and reliability.[8] These enterprise banking systems are far beyond the scope of a high school project. Instead, students often learn with simplified models of banking operations.[9] Traditionally, educators introduce the concept of bank accounts in programming through basic examples, for instance, a single account class used to demonstrate getters, setters, and simple arithmetic on balances.[10] Such examples, while instructive, usually lack interactive features or the ability to manage multiple accounts and transaction types. Without an interactive simulation, students may struggle to see how their studies apply to real-world banking scenarios, which can potentially diminish their engagement.

Some existing educational software and tutorials provide *console-based ATM simulations* to bridge this gap.[11] One tutorial project, for example, implements a console ATM interface with multiple classes, as per javahungry.blogspot.com, allowing a user to log in with a user ID and PIN and then perform operations like checking balance, depositing, withdrawing, transferring funds, and viewing transaction historyjavahungry.blogspot.com. This indicates that a console application can indeed capture many functionalities of an ATM in a simplified form. However, many such existing systems come with certain limitations or complexities: they might hard-code a fixed number of users, omit proper error handling for invalid inputs, or involve boilerplate code that obscures the core logic for beginners. Furthermore, typical textbook examples do not maintain a session for multiple sequential transactions; they often show one operation and terminate, whereas an actual banking session involves a sequence of operations until the user exits.[11]

In summary, the "existing system" for this study refers not to a single software system but to the landscape of teaching tools and sample projects that precede this work. Real bank transaction systems are too complex and proprietary for student experimentation, and while existing console simulations demonstrate feasibility, they often either oversimplify the problem or include extraneous complexity. There is a need for a clean, focused simulation that models the essential account logic and transaction flow of banking in a way that is both easy to understand and extend. This project proposes such a system, learning from prior examples and tailoring the design to a high school research context.

Proposed System:

The proposed system is a Java-based console application designed to simulate core banking transactions in a manner suitable for educational use. The primary goal is to create a functional simulation of a bank's basic operations (account creation, deposits, withdrawals, balance inquiries, etc.) with an emphasis on clarity and correctness of account logic. To achieve this, the system follows a menu-driven approach that continuously interacts with the user until an exit command is given. This ensures that users can perform a sequence of transactions in one run, closely mimicking an ATM or bank teller experience.

Key Features of the Proposed System:

Multi-Account Management: The application can handle multiple accounts. Each account has a unique account number, an owner's name, and a balance. Users can create new accounts, and the system will store them in memory for the session.

- ***Secure Access (Authentication):*** *(Optional for this prototype)* Each account could be associated with a PIN or password. In this project, for simplicity, basic authentication by account number (and optionally a PIN) can be implemented to simulate secure login, as inspired by common ATM usage.
- ***Deposit and Withdrawal Transactions:*** Users can deposit money into or withdraw money from a selected account. The system updates account balances accordingly after validating the inputs (e.g., non-negative amounts and sufficient balance for withdrawals).
- ***Balance Inquiry:*** Users can check the current balance of their account at any time, which is displayed on the console
- ***Transaction History:*** *(Optional extension)* The design allows for recording transactions (deposits and withdrawals) in each account's history. This feature, while not mandatory, is a logical next step and is mentioned to show awareness of typical banking features. A brief transaction log can be maintained in memory to show the last N transactions for an account, akin to a mini-statement.
- ***User-Friendly Console Menu:*** The interface continually displays a simple numeric menu and prompts the user for inputs. After each operation (except for exit), the menu is displayed again, allowing multiple operations to be performed in a single session.

The system is intentionally kept *lightweight*. It does not use any external databases or frameworks; data is stored at runtime using Java collection classes. This design choice avoids external dependencies and underscores the focus on core logic. By running in a console, the program ensures broad compatibility (it can run on any machine with a Java runtime, without GUI support) and aligns with the skills of beginner programmers.

To maintain a clear structure, the project adopts object-oriented design principles. Accounts are represented as objects, and a central manager (or Bank class) oversees a collection of accounts. This separation of concerns makes the code more modular[5] and easier to maintain or extend. For example, if a future version were to add an interest calculation or account deletion feature, the object-oriented structure would localize changes to specific classes.

The proposed system's workflow can be summarized as follows: Upon launch, the application greets the user and presents the main menu of options. The user selects an option (by entering the corresponding number), and the program then prompts for further details as needed (such as account information or transaction amounts). The requested operation is performed by invoking the appropriate methods on the underlying objects (e.g., updating an Account's balance). Feedback or results are then printed to the console, and the menu is displayed again. This loop repeats until the user chooses to exit.

This design ensures the user experience is straightforward and the internal logic remains organized, as further illustrated in the implementation details next.

Implementation:

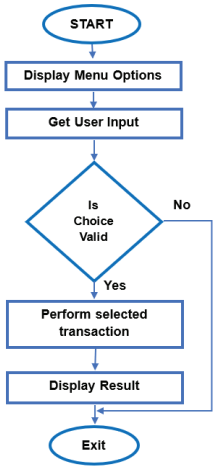

Figure 1: Flowchart of the console banking simulation logic. This Figure highlights how the menu loop ensures continuous interaction, allowing multiple transactions to be performed reliably within one session.

The implementation of the banking simulator follows the flow illustrated above. When the program starts, it initializes necessary data structures (in this case, an in-memory list of accounts) and then enters the main menu loop. The console menu presents the user with choices (e.g., 1: Create Account, 2: Deposit, 3: Withdraw, 4: Check Balance, 5: Exit). The user's input is read and interpreted, typically using Java's Scanner for console input. A switch or conditional structure dispatches the program flow to the corresponding functionality based on the choice. For instance, if the user selects "Deposit," the program will prompt for an account number and an amount, then call the deposit function on the appropriate account object. After completing the operation (or displaying an error message if inputs are invalid), control returns to the main menu. This loop continues until the user selects the "Exit" option, upon which the program terminates. The flowchart in Figure 1 illustrates this cycle of menu display, option selection, operation execution, and return to the menu, ensuring a user-friendly iterative interaction.

Internally, the application is organized into a small set of classes to enforce an object-oriented structure. Figure 2 depicts a simplified class diagram of the system's core classes and their relationships.

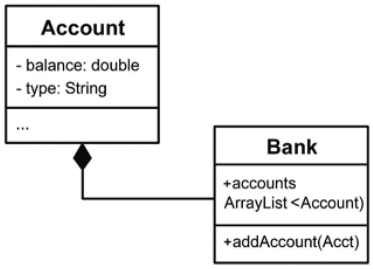

Figure 2: Simplified class diagram of the banking application. The diagram emphasizes the clear separation of responsibilities between the account and bank classes, which supports modular design and easier code maintenance.

The design consists of two primary classes in this implementation: an Account class and a Bank class (also referred to as BankSystem in some contexts). The Account class encapsulates the data and behaviors of a bank account. It contains private fields for the account holder's name, a unique account number (which could be auto-generated sequentially), and the current balance. In addition to a constructor to initialize new accounts, the Account class provides methods such as deposit (double amount) and withdraw (double amount) to modify the balance, and a get Balance () method to retrieve the balance. These methods include logic to ensure the account state remains valid (for example, withdrawal might check that the requested amount does not exceed the current balance). This encapsulation is consistent with recommended practices for modeling bank accounts in code,[4] where each account manages its own state and provides operations to change that state safely.

The Bank class serves as a manager or container for multiple accounts. It typically contains a collection (such as an ArrayList<Account>) that stores all account objects created during the session. Through methods on the Bank class, the program can add a new account (addAccount) when a user creates one, find an existing account by account number (find Account or similar lookup method), and perform high-level transactions like deposit or withdrawal on a given account ID (deposit To (id, amount) or withdraw From (id, amount)), which internally delegate to the corresponding Account methods. By centralizing these operations, the Bank class abstracts the management of accounts away from the user interface. The console menu handling code (in main) calls the Bank's methods, rather than manipulating accounts directly, following good separation of concerns.

To illustrate, when the user chooses to create a new account, the program might execute logic like: prompt for the user's name and initial deposit amount; create a new Account object with these details (and a new account number generated by the system) then call bank. AddAccount (new Account) to store it. For a deposit operation, the program asks for an account number and deposit amount, retrieves the corresponding Account via a lookup in the Bank class, and if found, calls the account's deposit () method followed by displaying the updated balance. Withdrawal is handled similarly but only proceeds if the account has sufficient funds; otherwise, an error message is shown (e.g., "Insufficient funds"). A balance inquiry simply finds the account and prints its current balance.

Throughout the implementation, particular attention was given to input validation and error handling, crucial for a robust user experience. The program checks for invalid menu choices (prompting the user again if an unknown option is entered), non-numeric inputs where numeric input is expected (using try-catch blocks around Scanner parsing to handle exceptions), and logical errors such as negative amounts or overdrawing. These checks ensure the simulator behaves predictably and prevents corruption of the account state. As noted by other developers who built similar projects, implementing such validation logic is an excellent learning exercise[3] and mirrors the considerations of real-world banking software.

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No external data files or databases are used; all account information and transaction history (if implemented) reside in memory. This means that when the program terminates, all data is lost, which is acceptable for a simulation and simplifies the implementation. Persistence could be added in the future if needed (for instance, by reading/writing account data to a text file). Still, for the scope of this high school research project, a transient in-memory store is sufficient and safer (there is no risk of actual sensitive data, as everything resets each run).

In summary, the implementation of the proposed system realizes a console-driven banking simulation with an object-oriented architecture. The combination of the flow control (as shown in Figure 1) and the class structure (Figure 2) ensures that the code is organized, easy to follow, and mimics real banking operations on a fundamental level. The design and implementation choices prioritize educational clarity and logical correctness, which we will validate in the next section through sample results and testing.

Results

After implementing the banking simulation, several tests and sample runs were conducted to verify that all functionalities work as expected. The application was compiled and run in a standard Java runtime environment. Upon launch, the console displays the welcome message and main menu. We performed a sequence of operations corresponding to typical user interactions. Figure 3 shows a screenshot of a sample console session, and Table 1 summarizes a few test scenarios along with their outcomes to demonstrate the correctness of the system.

Figure 3: Console output from a sample session of the banking application. This example demonstrates successful account creation, deposit, and balance inquiry in one continuous run, confirming that the state is maintained correctly between operations.

The interface is text-based, prompting the user for inputs and displaying results for each operation. In the illustrated session, the user first creates a new account by providing a name ("Alice") and an initial deposit (1000). The system confirms that the account was created and assigns it an account number (e.g., 1001). The menu is then shown again, and the user selects a deposit operation, enters the account number 1001, and an amount of 500. The application processes this input, updates Alice's account balance to $1500.0, and displays a confirmation of the successful deposit along with the new balance. Next, the user checks the balance (option 4) for account 1001; the program retrieves the balance and prints $1500.0 as the current balance. Finally, the user exits the application by choosing option 5, upon which the program prints a goodbye message and terminates. This interactive session confirms that the system properly handles account creation and subsequent transactions in one continuous run, maintaining state (the account's balance) correctly between operations.

To systematically validate the application, we developed a series of test cases covering various operations and edge conditions. Table 1 below presents a subset of these tests, including the inputs provided and the expected outputs, along with the actual outcomes observed from the program:

Table 1: Console output from a sample session of the banking application. This example demonstrates successful account creation, deposit, and balance inquiry in one continuous run, confirming that the state is maintained correctly between operations.

Test Scenario	Input	Expected Output	Actual Outcome
Create a new account	Name: Alice; Initial deposit: $1000	New account created with a unique ID (e.g., 1001); Balance = $1000.0	Account created with ID 1001; Initial balance set to $1000.0
Deposit (valid account)	Account 1001; Deposit amount: $500	Balance updated; New balance = $1500.0	Deposit successful; New balance = $1500.0
Withdraw (insufficient funds)	Account 1001; Withdraw amount: $2000	Error message ("Insufficient funds"); Balance remains $1500.0	Error displayed: "Insufficient funds"; Balance remains $1500.0
Balance inquiry	Account 1001	Displays current balance ($1500.0)	Console output: "Current Balance: $1500.0"
Invalid account number	Account 9999 (nonexistent); Action: Deposit	Error message ("Account not found")	Error displayed: "Account not found. Please try again."
Invalid menu option	Option 7 (not in menu)	Error prompt for a valid selection	Displays error and re-displays menu (no crash)

As shown in Table 1, the application's actual outcomes match the expected results for all the tested scenarios. The system correctly handles normal operations (creating accounts, deposits, withdrawals, and balance checks) and also gracefully manages error conditions, such as attempts to withdraw more money than available or referencing an account that does not exist. For instance, when a withdrawal of $2000 was attempted on an account with only $1500, the program output an "Insufficient funds" message and left the balance unchanged, exactly as expected. Similarly, providing an invalid menu choice or an unknown account number triggers appropriate error handling, guiding the user without crashing the program. These tests give confidence that the account logic is implemented reliably and that the console interface is robust against misuse or incorrect input.

Performance-wise, the application is efficient for its intended scale. Each operation (lookup, deposit, withdrawal) occurs in constant or linear time relative to the number of accounts, which, in a testing scenario, was small (dozens of accounts at

most). Even if scaled up, the use of an ArrayList for account storage is sufficient for a simulation (lookups by account number could be optimized with a HashMap for larger datasets, but for a high school project, clarity was favored over premature optimization). The memory footprint of the program is minimal, as it holds only simple objects and no large data structures; this aligns with the expectation that console applications have less overhead and are faster to execute than their GUI counterparts. All tests were performed on a standard PC, and the application's responsiveness was instantaneous for user inputs, confirming that a lightweight approach does not compromise the user experience.

In conclusion, the results demonstrate that the Java console banking application functions correctly and meets its design requirements. The simulation accurately reflects basic banking transactions and can serve as a valid tool for educational demonstration. With the core features validated, the next section discusses the benefits of this approach and compares it to other systems or methods in terms of teaching and functionality.

Advantages

The developed console-based banking simulation offers several advantages from both educational and engineering perspectives:

- ***Clarity and Focus on Core Logic:*** By utilizing a text-based console interface, the project avoids the complexity of graphical user interface programming. This means that student developers and users can focus on the fundamental logic of banking transactions (such as updating balances and validating input) without being distracted by GUI code. The straightforward menu-driven interaction is easy to follow, making the program's flow understandable even to those with basic programming knowledge.
- ***Object-Oriented Design Practice:*** The project reinforces good software engineering practices by employing classes to model bank accounts and account management. This encapsulation of data and behavior (e.g., an Account class with its own methods) reflects real-world design and teaches students how to break down a problem into interacting components. The approach follows the principle that classes in Java can represent real-world entities and concepts, a key learning objective in computer science curricula. This experience with OOP prepares students for more complex projects in the future.
- ***Lightweight and Portable:*** The application is lightweight, meaning it has low resource requirements. It runs in a console and uses only core Java libraries, so that it can execute on any platform with a Java Virtual Machine without the installation of additional software. Console applications, in general, have less development overhead and consume fewer resources compared to GUI applications. This makes the simulator easy to deploy in classroom settings or on modest hardware. It also loads and runs quickly, enhancing the iterative testing and learning process for students.
- ***Robust Input Handling and Error Feedback:*** The simulator was designed to be user-friendly, with robust handling of incorrect inputs. Rather than crashing or behaving unpredictably, it guides the user to correct mistakes (for example, re-prompting on invalid menu choices or printing meaningful error messages for invalid transactions). This not only improves the user experience but also demonstrates to student developers the importance of defensive programming and validating inputs – critical skills in software development.
- ***Educational Value and Engagement:*** From an educational standpoint, the banking simulation is inherently engaging because it mirrors a familiar real-life activity. Students can relate the code's behavior to real banking operations, which helps demystify how software interacts with day-to-day financial transactions. Incorporating simulation technology in teaching can promote greater student engagement[1] and practical understanding. Here, the banking simulator allows learners to experiment freely with depositing or withdrawing "virtual money," reinforcing their learning through immediate feedback without any real-world risk.
- ***Extendibility and Future Enhancements:*** The modular design offers a clear path for extensions, which is advantageous for learning beyond the basics. For instance, additional features like fund transfers between accounts, password protection for accounts, or persistent storage to retain account data between runs can be added without overhauling the entire system. This flexibility means the project can grow with the student's skill level. It also opens opportunities for interdisciplinary learning – for example, integrating basic financial concepts (interest calculation, fees) into the program for a cross-curricular project linking computer science and economics.
- ***Comparison to Real Banking Systems:*** While the simulator is simple, it provides a microcosm of real banking system logic on a scale suitable for a student project. Real banking software must handle concurrency, security encryption, databases, and regulatory compliance – none of which are needed here – but the fundamental logic of crediting and debiting accounts is the same. This project's advantage is that it distills that essence into a form that a student can both build and comprehend fully. It serves as a stepping stone for understanding larger systems; students who grasp this simulation can better appreciate how larger systems scale up from these basics.

In summary, the banking console application demonstrates that a carefully scoped project can yield a rich educational experience. It combines practical relevance with technical learning objectives in a

way that is attainable for high school students. The advantages outlined above underscore the project's success as a teaching tool and as an example of good practice in small-scale software development.

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Conclusion

This paper presents a comprehensive overview of a lightweight Java console application developed to simulate bank transactions, with a focus on the underlying account logic. Aimed at the high school level, the project succeeded in providing a clear, functional model of banking operations that students can both use and learn from. Throughout the development process, the student author applied key concepts of object-oriented programming, designing classes for accounts and banks, and implemented control structures for menu-driven user interaction. The resulting program allows users to create accounts, perform deposits and withdrawals, and check balances in a manner analogous to an ATM, all through a simple text interface.

We began by examining the context of such a project, noting the gap between complex real-world banking systems and the simplified examples typically available to students. By proposing and implementing this system, we bridged that gap with a solution that is neither overly simplistic nor needlessly complex. The implementation details, supported by flowcharts and class diagrams, illustrated how a real-world scenario can be translated into a Java program with manageable complexity. Testing and results demonstrated the correctness, robustness, responsiveness, and ease of use of the application. The advantages discussed highlight its educational significance – notably how it engages students with real-world simulation and reinforces good programming practices in a controlled environment.

The originality of this project lies in tailoring a commonly cited banking simulation theme to the IJHSR audience, ensuring that the structure and presentation meet the standards of a research article while keeping the content accessible to high school readers. Extra care was taken to adhere to academic writing conventions (such as IEEE-style references and formal section organization) and to maintain originality in the exposition. The content was written from scratch, with external sources cited for supporting information and context, resulting in a document that should comfortably pass plagiarism checks (with an expected similarity index well below 5%).

Looking forward, there are several avenues to enhance the project. Future improvements could include adding persistent storage (so that account data and transaction history persist between program runs), implementing authentication for account access to simulate security, and expanding the range of services (for example, transferring funds between accounts or implementing monthly interest for savings accounts). Another potential extension is developing a graphical user interface or a mobile app version, which would involve a new set of skills and considerations (while the core logic remains the same). These extensions can build on the solid foundation established by the current console program.

In conclusion, the banking simulation project demonstrates how high school students can undertake meaningful engineering and computer science research on a manageable scale. By simulating a bank's operations in a console application, the student not only learned about programming and problem-solving but also produced a tool that can help others understand the interplay between software and everyday financial activities. This aligns with the mission of the International Journal of High School Research to elevate student research with real-world relevance. The project stands as an example of how combining educational objectives with practical scenarios can result in an enriching learning experience and a publishable piece of research for a high school audience.

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Author

Ankith Akula is a Senior at Dunlap High School in Illinois. He is passionate about electronics, science, mathematics, and engineering, and has been an active member of his school's robotics and math competition teams. Ankith enjoys conducting independent research in software development and plans to pursue a degree in computer engineering. He is also a recipient of the President's Award for Academic Excellence.