

**SETU Code Lab**

**Research Document**

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[Date of Submission]

Table of Contents

[Abstract 3](#_Toc211267858)

[Introduction 4](#_Toc211267859)

[Technologies 5](#_Toc211267860)

[Front-End 5](#_Toc211267861)

[React 5](#_Toc211267862)

[Vite 5](#_Toc211267863)

[TypeScript 6](#_Toc211267864)

[SCSS 6](#_Toc211267865)

[Back-End 7](#_Toc211267866)

[Node.js 7](#_Toc211267867)

[Database 7](#_Toc211267868)

[PostgreSQL 7](#_Toc211267869)

[Code Editors 8](#_Toc211267870)

[Monaco 8](#_Toc211267871)

[CodeMirror 8](#_Toc211267872)

[Ace 8](#_Toc211267873)

[Code Sandboxing 9](#_Toc211267874)

[Testing 10](#_Toc211267875)

[Gamification 11](#_Toc211267876)

[Similar Platforms 12](#_Toc211267877)

[Conclusion 13](#_Toc211267878)

[Appendix 14](#_Toc211267879)

[Glossary 15](#_Toc211267880)

[Bibliography 16](#_Toc211267881)

# Abstract

# Introduction

# Technologies

## Front-End

The front-end of SETU Code Lab needs to be clean, responsive and user-friendly so that users can focus on solving coding problems rather than learning how to navigate the platform. The chosen technologies for the front-end are React, Vite, TypeScript, and Tailwind CSS. They have been chosen for their modularity, easy interactivity, performance and support of modern browsers.

### React

React is an open-source JavaScript library developed by Meta (formerly Facebook) and first released in 2013 (GeeksforGeeks, 2025). It is used for building user interfaces and works by allowing the developer to create reusable user interface (UI) components. These components can then be put together to construct the full UI. React uses a virtual DOM (Document Object Model) to optimize rendering and improve performance by only updating the parts of the UI that have changed and not the whole page (Meta Platforms, Inc., 2025).

#### Angular

Some alternatives to React that were considered were Angular and Vue. Both Vue and Angular also use reusable UI components. Angular is full-featured framework developed by Google and released in 2010, with a more opinionated architecture suitable for larger-scale, enterprise-level applications. React on the other hand is a more lightweight and flexible, component-based library. React was chosen instead of Angular due to its simplicity, ease of integration with other libraries and suitability for more medium sized applications (Google, 2025), (GeeksforGeeks, 2025).

#### Vue

Vue is a front-end framework developed by Evan You and first released in 2014. Vue was considered as a potential front-end technology for this project due to its simplicity, high performance and reactive two-way binding, which allows automatic synchronization of the UI and the underlying data (GeeksforGeeks, 2025). React in comparison only allows data to move in one direction, from parent components to child components. However, the MobX state management library allows for the implementation of two-way binding if needed (MobX, 2025).

React was ultimately chosen instead of Vue because this unidirectional data flow simplifies debugging and state management. It is also more flexible than Vue and integrates more naturally with the chosen technology stack, particularly TypeScript which provides strong static typing and full compatibility with JSX the syntax extension used by React (Microsoft, 2025).

### Vite

Vite is a modern front-end build tool and development server known for its fast speed, simplicity and support of modern browsers. It offers Hot Module Replacement (HMR) which updates the react application instantly in the browser without needing a full page reload. Vite has been chosen as a build tool for use with React to speed up development and for its support of the latest versions of modern browsers (Vite, 2024).

### TypeScript

TypeScript is a syntactic superset of JavaScript developed by Microsoft and first released in 2012. It extends JavaScript by adding static typing, which allows compile-time type checking. This means TypeScript will report any mismatched type errors before running the code whereas JavaScript will not. This is very helpful for debugging and helps improve the quality and performance of the code. For these reasons, TypeScript has been chosen over JavaScript for development (Microsoft, 2025).

### SCSS

SCSS is a stylesheet language that is compiled into CSS. SCSS syntax is fully compatible with CSS and includes more advanced features such as variables, nested rules, mixins, and built-in modules. SCSS variables differ from CSS variables in that CSS variables have different values for different elements, whereas SCSS variables remain the same across multiple elements. This is very useful for reducing code repetition. Nested rules further reduce code repetition by letting an inner rule inherit selectors from an outer rule. Mixins are reusable blocks of CSS that can be defined and used throughout the stylesheet mixed in with other styles. The Built-in modules feature provides functions that are useful for manipulating numbers, strings, colours and more, making it easier to build dynamic stylesheets (SASS Team, 2025). For these reasons SCSS has been selected as the stylesheet language for SETU Code Lab.

#### Tailwind CSS

Tailwind CSS was also considered as a potential alternative to SCSS due to its utility classes and potential for rapid development. Tailwind utility classes allow developers to combine many single purpose utility classes directly in the markup i.e. not in a dedicated CSS file. This allows changes to be made faster as the developer does not have to consider what to name their classes and how their changes will affect other pages. Tailwind is also efficient as it purges any unused CSS, reducing the final bundle size (Tailwind Labs, 2025).

One issue with Tailwind CSS is that its utility first approach makes readability and maintainability more difficult as all styles are applied in an inline fashion. This bloats the codebase and becomes a headache for the developer. Another issue with Tailwind is that it’s utility first design and lack of dedicated stylesheets is unfamiliar to new developers. Due to these reasons and the additional features present in SCSS, SCSS has been chosen ahead of Tailwind CSS.

## Back-End

### Node.js

Node.js is an open-source JavaScript runtime environment. It allows developers to run JavaScript outside of the web browser. It is asynchronous and event-driven meaning it can handle multiple tasks at once without blocking others, making it very efficient. It is built on Google’s V8 JavaScript engine, which compiles JavaScript into machine code, resulting in a high level of performance. It’s large ecosystem of packages available through npm (Node Package Manager) also make it a popular choice for backend development (OpenJS Foundation, n.d.).

Node.js was chosen for SETU Code Lab due to its seamless integration with React and TypeScript, its high performance and its large number of useful libraries available through npm.

## Database

### PostgreSQL

PostgreSQL is a relational database management system known for its reliability, performance and robust features. With nearly forty years of active development PostgreSQL offers advanced features such as full-text search, JSON support and custom data types (PostgreSQL, 2025).

Instead of searching for exact strings, full-text search can find results that semantically match. For example, if a student entered a search containing the word “loop”, PostgreSQL can return any problems whose titles or descriptions contain the word “loop” or similar words such as “loops” or “looping”. Support for JSON is useful as the system may need to store some semi-structured data such as problem test cases or results data. Support for custom data types is also needed for SETU Code Lab as there will be many custom data types such as difficulty level for example (e.g. easy, medium, hard) (PostgreSQL, 2025).

## Code Editors

SETU Code Lab aims to have a built-in code editor in the browser in which the user can input their solution code. This editor needs to be fast, reliable and user friendly. Several libraries have been identified for this task such as Monaco, CodeMirror and Ace. These are all available through npm and compatible with the rest of the chosen technology stack.

### Monaco

Monaco is the code editor used by Visual Studio Code and thus has the same look and feel. It is written in TypeScript, and the latest version is version 0.54.0. It has many of the same features as Visual Studio Code such as IntelliSense meaning it has a rather large bundle size. IntelliSense is Visual Studio Codes signature code completion, content assist, and code hinting tool. This functionality can be enabled or disabled as needed and supports almost any programming language (Microsoft, n.d.).

### CodeMirror

CodeMirror is another feature rich code editor though it has a much smaller bundle size compared to Monaco (153kb vs 21.3kb) (NPM, 2025) (NPM, 2025). It is written in JavaScript, and the latest version is CodeMirror 6. Some of the potentially useful features include syntax highlighting which colours code to reflect its syntactic structure, language specific autocompletion hints, accessibility support for screen readers and keyboard only users and undo and redo functionality. CodeMirror also remains responsive even for very large documents (Haverbeke, n.d.).

### Ace

The Ace code editor is another lightweight, embeddable code editor like CodeMirror. It has many of the same features such as syntax highlighting, code folding, themes and customizable key bindings. It also includes basic autocompletion and search and replace functionality (Ace, 2024). While Ace provides good language support and performance, its architecture is older and less modular compared to CodeMirror or Monaco. This means it can be more difficult to integrate with React (Masad, 2025).

In conclusion CodeMirror 6 has been selected as the code editor for SETU Code Lab as it strikes the right balance between performance, due to its small bundle size, functionality, which is extensible if needed and ease of integration with front-end frameworks such as React.

# Code Sandboxing

When a user of SETU Code Lab runs or submits a solution to a code problem, it must be run safely in a containerized environment. This is to prevent any potentially malicious code from causing harm. Running code inside a docker container for instance allows developers to: limit the amount of system resources available, preventing any Denial of Service (DOS) type attacks and disable outbound networking, preventing any network abuse or exfiltration of data.

# Testing

# Gamification

# Similar Platforms

# Conclusion

# Appendix

# Glossary

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