A critical reflection on refactoring the Web Witchcraft and Wizardry project

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December 18, 2025

Abstract

This is a personal reflection on the design and implementation of a refactored version of a website. The new architecture is described, along with the navigation design, responsive and accessibility features, testing strategy, known issues and future improvements. Third party credits and resources are also acknowledged.

1   Introduction

Web Witchcraft and Wizardry (Mulligan, 2024) is a website for children to learn the basics of web development through fantasy-themed metaphors. The original version of the website was neither accessible (except by accident) nor responsive. This essay reflects on the design and implementation of a refactored version of the project, focusing on architecture, accessibility and quality of the new code. Detailed decisions are documented as comments in the source code, which should be read alongside this essay, so the essay focuses on higher level design decisions and reflections.

For reference the old and new landing pages can be seen in figures 1, 2 and 3.
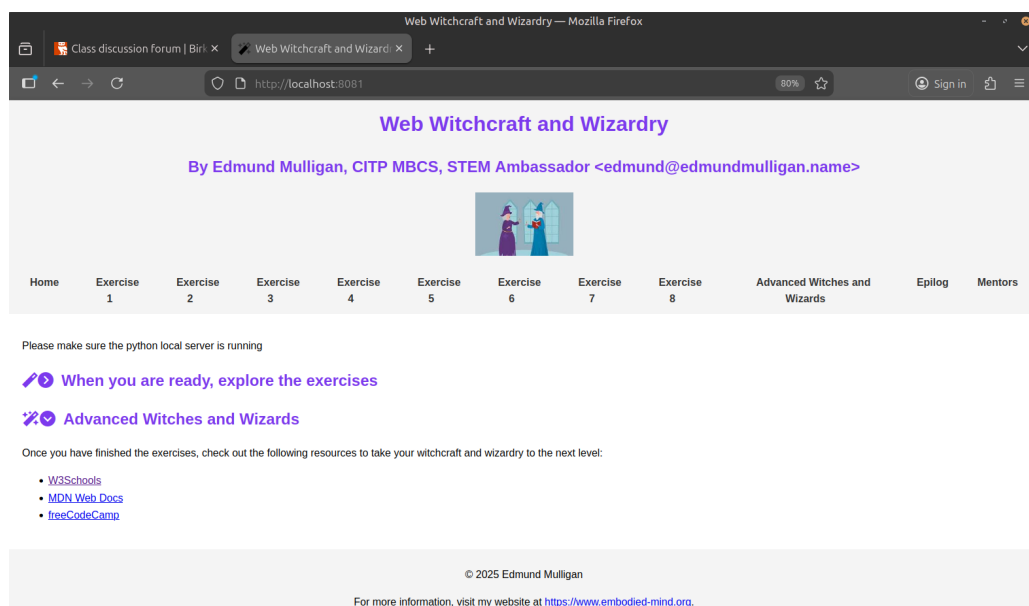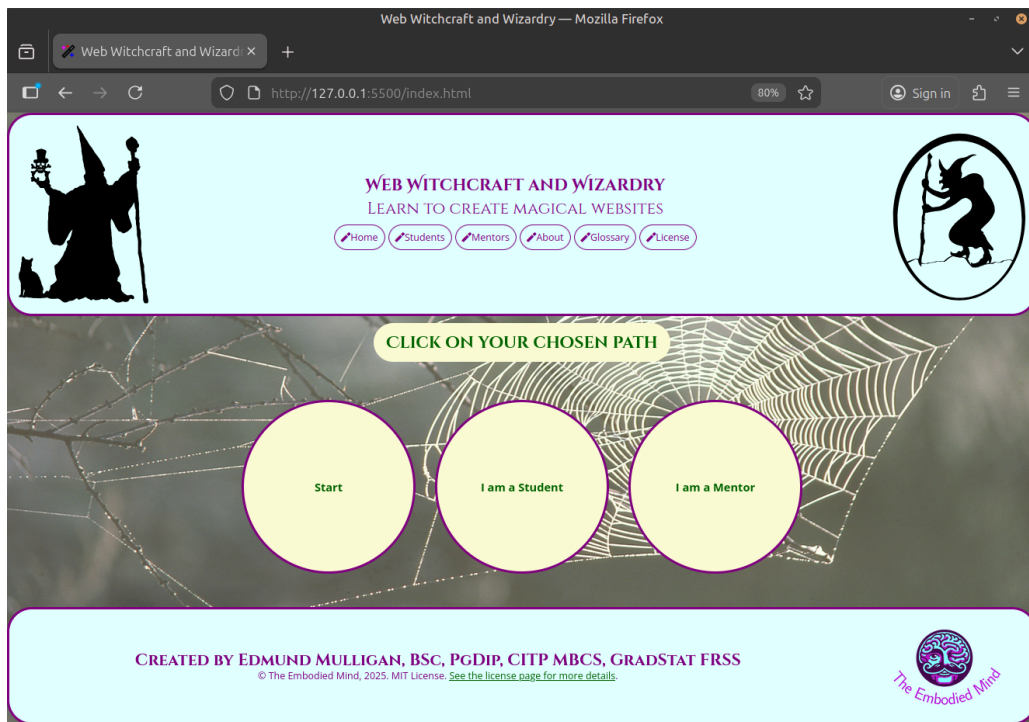

Figure 1: Old landing page
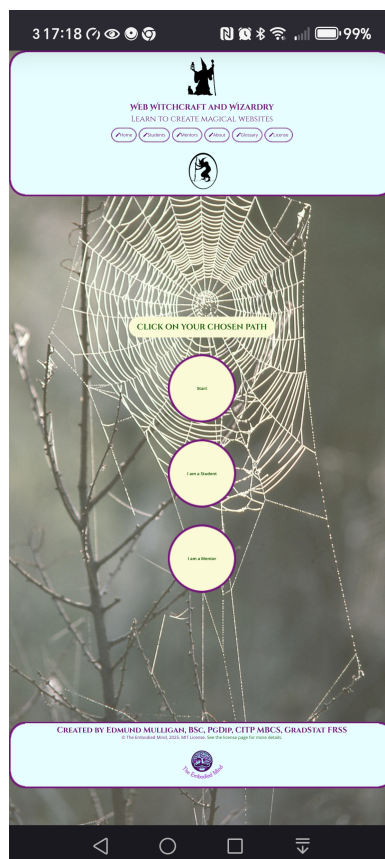
Figure 2: New landing page on a computer

Figure 3: New landing page on a mobile device

The development process used was iterative and incremental (Beck and Andres, 2004), and while there are many criticisms of this approach, particularly around its lack of documentation, endless changes and lack of scalability to large teams (see, for example, Boehm and Turner

2004), it was well suited to this small project with a single developer fulfilling all team roles.

This essay was written in parallel with the development of the website, so screenshots may not exactly reflect the final version of the code submitted for assessment, but are intended to illustrate the design decisions discussed.

2 Architecture

Even in a small project, software design principles are important to keep the code maintainable and extensible (Gamma et al., 1994). The three main principles applied in this project were separation of concerns (Parnas, 1972), DRY (Don't Repeat Yourself) (Hunt and Thomas, 1999), and self-documenting code (Martin, 2008). The first principle lead to the folder structure shown in figure 4. The second principle influenced the use of JavaScript to inject common elements (header, footer, in-page navigation) into each page at runtime, rather than duplicating the code in each HTML file. This also inspired the use of CSS variables to define common colours and other styles in one place, rather than duplicating these values throughout the CSS files. The third principle was followed throughout the codebase with meaningful names for files, classes, etc., and comments where necessary to explain non-obvious decisions. A consistent naming convention was used throughout, specifically kebab-case for file names, class names and IDs, and camelCase for JavaScript variables and functions (although, admitedly, there is currently only one JavaScript function).

```
root/
├── index.html
├── sitemap.xml
├── sitemap.xls
├── bin/
│   └── (build and test scripts)
├── images/
│   ├── (site images)
│   └── fontawesome/
│       └── (svg fontawesome icons)
├── pages/
│   ├── about.html
│   ├── glossary-and-faq.html
│   ├── license-and-credits.html
│   └── students.html
├── scripts/
│   ├── inject-header.js
│   ├── inject-footer.js
│   └── inject-in-page-navigation-*.js
└── styles/
    ├── main.css
    ├── noscript.css
    ├── components/
    │   ├── buttons.css
    │   ├── header-and-footer.css
    │   ├── navigation.css
    │   └── titles.css
    ├── media-queries/
    │   ├── about.css
    │   ├── header-and-footer.css
    │   ├── index.css
    │   ├── license-and-credits.css
    │   ├── navigation.css
    │   ├── students.css
    │   └── titles.css
    └── pages/
        ├── about.css
        ├── glossary-and-faq.css
        ├── index.css
        ├── license-and-credits.css
        └── students.css
```

Figure 4: Directory structure of the project

3   Navigation

Navigation design was kept simple with a top navigation bar for site-wide navigation (figure 5) and an in-page navigation bar for navigating within all pages except the landing page (e.g. figure 6, although each page is slightly different). Incidentally, the wizard and witch in the site header are informally known to the development team as 'Joe' and 'Helena' respectively.
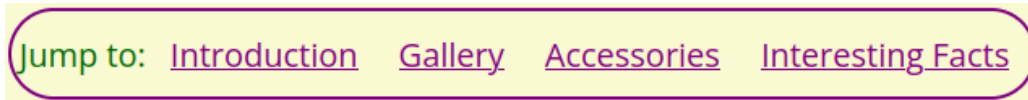
Figure 5: Site navigation bar structure

Figure 6: In-page navigation bar structure

4 A Responsive and Accessibile Website

A primary goal of the refactor was to make the website responsive and accessible. Indeed, this is my main personal learning outcome for this module. My thinking in this area has been highly influenced by two YouTube channels, those of Kevin Powell (Powell, 2025) and Coding2GO (Coding2GO, 2025), both of whom produce video tutorials and discussions on modern web development techniques.

The primary techniques used to achieve responsiveness are media queries and flexible layouts (Marcotte, 2010). Accessibility features were mainly implemented by ensuring the code conformed to web standards, (Caldwell et al., 2024), but also by following best practices in the HTML markup, such as using semantic HTML elements (WHATWG, 2025),

4.1 Using and avoiding media queries

A point Powell makes in several videos is that while media queries are important, they should not be overused. The main layout should be flexible enough to adapt to a wide range of viewport sizes without the need for frequent breakpoints. Exactly which breakpoints to use is a matter of experience (which I lack) and judgement (which I possess in abundance), and I eventually settled on the following standardised breakpoints across all pages:

In order to minimise the use of media queries, I used the clamp() CSS function to define fluid typography that scales smoothly between a minimum and maximum size, rather than jumping between discrete sizes at breakpoints. A limitation of this is that if the middle value of clamp() is defined using a viewport width unit (vw), then the text will not scale if the user zooms their browser without changing the viewport window size. This contravenes WCAG 2.2 Success Criterion 1.4.4 (Caldwell et al., 2024) which requires text to be resizable up to 200%

Viewport width	Layout	Impact
0px to 80px	Too small to be useable	
81px to 200px	Very small	Warn users but make best effort to display contents reasonably
201px to 800px	Mobile layout	Prefer vertical stacking
801px and above	Desktop layout	Prefer horizontal layout

Table 1: Viewport width breakpoints

without loss of content or functionality. A clever workaround recommended by Powell is to calculate the middle value of clamp() from a vw unit and a rem unit, so that zooming the browser window also changes the text size.

One downside of this approach is that it takes a lot of trial and error to find suitable values to pass to clamp() that work well across a wide range of viewport sizes and this took up most of my testing time. Indeed, I would say that this is still a work in progress and further refinements could be made in future phases.

4.2 Flexbox vs Grid

4.3 Units of measurement

Another way to achieve responsiveness is to use relative units of measurement rather than absolute units. Thus, I used rem units for font sizes, padding and margins, and percentages for widths of containers. I avoided using px units except where absolutely necessary such as in media queries where absolute measurements are required. I preferred rem units over em units as rems are relative to the root font size, making them more predictable, whereas ems are relative to the font size of the parent element, which can lead to unexpected results if not carefully managed.

4.4 Other accessibility features

ARIA roles and attributes
choice of colours and contrasts
keyboard navigation
alt text for images

5 Testing

Testing software is not only a critical part of development (Myers et al. (2011),Mesbah et al. (2012)), but it is also difficult and time consuming. Many authorities (e.g. Boehm (1981), Jones (2008)) claim that testing can take at least 50% of total development time, and that concurs with my experience.

My approach to testing was to automate as much as possible using open source tools (see Appendix A for results). The tests were designed to check for compliance with web standards (as a proxy for accessibility) and (given the age of the target users) text readability. Both static and dynamic tesing tools (Myers et al., 2011) were used — static tools to check code validity, and dynamic tools to check accessibility of the rendered pages.

The tests were run frequently during development to catch issues early and ensure that the code remained compliant as code was refactored (regression testing). A github action was written to ensure the tests were run whenver code was pushed to the remote development and

main branches in github. Testing tools were discovered using a google search and the most popular ones were chosen:

- Lighthouse (Google, 2025)
- Axe (Deque Systems, 2025)
- Pa11y (**?**)
- Wave (WebAIM, 2025)

A script to check reading age using the Flesch-Kincaid formula (Flesch, 1948) and Gunning Fog index (Gunning, 1952) was developed using the text-readability node.js module (Aashish Khanal, 2025). Code was checked for validity using node.js modules html-validate (html-validate, 2025), stylelint (Stylelint Team, 2025) and eslint (ESLint Team, 2025). The official W3C validator for CSS (W3C, 2025) was not used as this cannot currently validate code with CSS variables. A simple script was written to ensure all files contained valid header comments. Browser compatibility was tested using Playwright (Microsoft, 2025) to run tests in multiple browsers and I acknowledge, with thanks, the assistance I received to get this working from a senior tester colleague at TfL. This allowed automated testing of the latest versions af all three major browser engines (Chrome, Firefox and Safari). Playwright has potential for much more and could enable a test driven developmeent (TDD) (Beck, 2003) approach in future phases of this project.

Implementing Wave testing was the most difficult as it requires a public URL to test and github pages are based on a private repository. Making the github repository public was considered and rejected as it could introduce unanticipated security risks so, after consultation with testing colleagues, ngrok (ngrok, 2025) was used to expose the localhost to allow Wave tests to complete.

There was insufficient time to fully evaluate the third party tools used and decide which was the best for this project, so a 'black box' approach was taken without investigaing exactly what each tool was testing. This did have the benefit that gaps in one tool's coverage could potentally be caught by one of the other tools, but it did introduce a problem of tools having conflicting standards. Wave, in particular requires the <h1> element to be in the <main> section, which would mean that the site title in the <header> section would have to be either an <h2> or a <p> element, which would be flagged by the other testing tools. Thus a decision to accept the warning from Wave was taken as the least bad alternative. The other alert from Wave was for the use of <noscript>, but this was simply a warning to check this usage as it may have accessibility implcations.

Automated testing is not a substitute for manual testing, and the site was also tested manually on a variety of devices, specifically

- A computer with a mouse and keyboard (running Linux Mint)
- A computer without using a mouse (to test keyboard navigation)
- A computer with a screen reader (Linux Orca)
- A touchscreen tablet device without mouse or keyboard (running Android)
- A mobile phone (running Android)

I did not have access to an iOS device so could not test on Apple hardware.

I did not test the website with JavaScript disabled and this is I acknowlege this as a limitation of the current testing, driven by the available time. Security, performance, and user testing were also not possible within the time constraints, but will be essential in the later phases where actual lessons are implemented and students' data are collected. In particular, expert testing from an experienced teacher will be needed to ensure the content is age appropriate and pedagogically sound.

6 Outstanding issues and Future Improvements

The poject submitted for assessment is phase one of a larger project to refactor and improve the Web Witchcraft and Wizardry website. Some content was deliberatly ommitted from this phase as it will be developed in phase 2 using JavaScript. There are also some known issues and areas for improvement that could not be addressed within the time constraints of this phase.

Issue Id	Description	Symptoms	Work around
1	Reactive code does not work well at extreme viewport sizes	Text overflows boxes or content does not fill screen properly.	Warning displayed when viewport is too small.
2	Font sizes are not optimal	Text is too small or too large on some devices.	Further refinement of clamp() values needed.
3	Images need editing. The artwork provided by Rachel Mulligan is in JPEG format with a white background.	The picture gallery looks unprofessional with white boxes around images.	Images need to be edited to have transparent backgrounds (PNG or SVG format).

Table 2: Known issues and workarounds

7 Third party credits and resources

All code submitted for assessment is my own work. No code has been copied from any external sources, such as online tutorials or code. I have, however, relied heavily on two YouTube channels, those of Kevin Powell (Powell, 2025) and Coding2GO (Coding2GO, 2025), for guidance on best practices and inspiration.

No Generative AI was used in creating code for this project, but I did make extensive use of Google Search which automatically generates AI summaries that cannot be disabled. I partly mitigated this by using Google Scholar where appropriate which at the moment does not use user accessible AI. I also used Stack Overflow (Stack Overflow, 2025) to troubleshoot specific issues I encountered.

The automation tools used for testing accessibility and performance (Lighthouse, Axe, pa11y, Wave) are all open source tools developed by third parties and the scripts used to run them were adapted from examples found in their respective documentations and in online resources. I was assisted by a colleague at my employer, Transport for London, in writing the playwright tests used for testing browser compatibility.

The artwork used in the website was created by Rachel Mulligan, a professional stained glass artist. I am grateful to her for allowing me to use her work in this project.

8 Conclusion

This has been a challenging and rewarding project. The challeng has not been coding the website, as I have 40 years of experience doing that, but in learning a lot of new material around modern CSS in a short space of time and applying that in a standards based development paradigm. The refactored Web Witchcraft and Wizardry website, while not yet complete, is a significant improvement on the original version in terms of accessibility, responsiveness and code quality. The use of automated testing has helped ensure that the code meets web standards

and is accessible to the target audience. There are still some outstanding issues and areas for improvement that will be addressed in future phases of the project.

Word count

Word count: 1993 words (excluding references)

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Appendices

A   Test Outputs

This appendix contains the complete test results from the automated test suite. All tests were executed on December 18, 2025 and demonstrate compliance with web standards, accessibility guidelines, and readability requirements.

Summary of Test Results

Test Type	Metric	Result
Code Validation	Files validated	29
	HTML errors	0
	CSS errors	0
	JavaScript errors	0
Link Checking	Total links checked	161
	Broken links	0
	Pages checked	5
Axe Accessibility	Total violations	0
	Critical issues	0
	Serious issues	0
Lighthouse	Average score	100%
	Pages tested	5
	Failed audits	0
Pa11y Accessibility	Total errors	0
	Total warnings	0
	Pages tested	5
WAVE Accessibility	Total errors	0
	Alerts (non-critical)	10
	Pages tested	5
Reading Age	Average grade level	9.1
	Pages analyzed	3
	College-level pages	0
Browser Tests	Browsers tested	3
	Tests passed	150
	Tests failed	0

Table 3: Summary of all automated test results

Detailed Test Results

The following sections contain the complete JSON output from each test suite.

Code Validation Results

```
1  {
     "files": [],
     "summary": {
       "htmlErrors": 0,
       "htmlWarnings": 0,
6      "cssErrors": 0,
       "cssWarnings": 0,
       "jsErrors": 0,
       "jsWarnings": 0
     }
11 }
```

Broken Links Check Results

```json
{
  "pages": [
    {
      "url": "index.html",
      "links": [],
      "brokenCount": 0,
      "totalCount": 19
    },
    {
      "url": "pages/students.html",
      "links": [],
      "brokenCount": 0,
      "totalCount": 40
    },
    {
      "url": "pages/glossary-and-faq.html",
      "links": [],
      "brokenCount": 0,
      "totalCount": 16
    },
    {
      "url": "pages/license-and-credits.html",
      "links": [],
      "brokenCount": 0,
      "totalCount": 36
    },
    {
      "url": "pages/about.html",
      "links": [],
      "brokenCount": 0,
      "totalCount": 45
    }
  ],
  "summary": {
    "totalLinks": 156,
    "brokenLinks": 0,
    "excludedLinks": 0
  }
}
```

Axe Accessibility Results

```json
{
  "violations": [],
  "passes": [],
  "incomplete": []
}
```

Lighthouse Accessibility Results

```
{
  "pages": [
    {
      "url": "index.html",
      "score": 1,
      "failedAudits": []
    },
    {
      "url": "pages/students.html",
      "score": 1,
      "failedAudits": []
    },
    {
      "url": "pages/glossary-and-faq.html",
      "score": 1,
      "failedAudits": []
    },
    {
      "url": "pages/license-and-credits.html",
      "score": 1,
      "failedAudits": []
    },
    {
      "url": "pages/about.html",
      "score": 1,
      "failedAudits": []
    }
  ]
}
```

Pa11y Accessibility Results

```
{
  "pages": [
    {
      "url": "index.html",
      "documentTitle": "Web Witchcraft and Wizardry",
      "pageUrl": "http://localhost:8080/",
      "issues": []
    },
    {
      "url": "pages/students.html",
      "documentTitle": "Web Witchcraft and Wizardry",
      "pageUrl": "http://localhost:8080/pages/students",
      "issues": []
    },
    {
      "url": "pages/glossary-and-faq.html",
      "documentTitle": "Glossary and FAQ|Web Witchcraft and Wizardry",
      "pageUrl": "http://localhost:8080/pages/glossary-and-faq",
      "issues": []
    },
    {
      "url": "pages/license-and-credits.html",
      "documentTitle": "Web Witchcraft and Wizardry",
      "pageUrl": "http://localhost:8080/pages/license-and-credits",
      "issues": []
    },
    {
      "url": "pages/about.html",
      "documentTitle": "About|Web Witchcraft and Wizardry",
      "pageUrl": "http://localhost:8080/pages/about",
      "issues": []
    }
  ]
}
```

WAVE Accessibility Results

```
1   {
      "pages": [
        {
          "url": "index.html",
          "errors": 0,
6         "alerts": 2,
          "features": 1,
          "structural": 7,
          "contrast": 0,
          "errorItems": [],
11        "alertItems": [
            {
              "id": "h1_missing",
              "description": "Missing first level heading",
              "count": 1
16          },
            {
              "id": "noscript",
              "description": "Noscript element",
              "count": 1
21          }
          ],
          "contrastItems": [],
          "waveUrl": "http://wave.webaim.org/report?url=https://crinkly-
              majorie-dramatic.ngrok-free.dev/index.html"
        },
26      {
          "url": "pages/students.html",
          "errors": 0,
          "alerts": 2,
          "features": 1,
31        "structural": 7,
          "contrast": 0,
          "errorItems": [],
          "alertItems": [
            {
36            "id": "h1_missing",
              "description": "Missing first level heading",
              "count": 1
            },
            {
41            "id": "noscript",
              "description": "Noscript element",
              "count": 1
            }
          ],
46        "contrastItems": [],
          "waveUrl": "http://wave.webaim.org/report?url=https://crinkly-
              majorie-dramatic.ngrok-free.dev/pages/students.html"
        },
        {
```

```
            "url": "pages/glossary-and-faq.html",
51          "errors": 0,
            "alerts": 2,
            "features": 1,
            "structural": 7,
            "contrast": 0,
56          "errorItems": [],
            "alertItems": [
              {
                "id": "h1_missing",
                "description": "Missing first level heading",
61              "count": 1
              },
              {
                "id": "noscript",
                "description": "Noscript element",
66              "count": 1
              }
            ],
            "contrastItems": [],
            "waveUrl": "http://wave.webaim.org/report?url=https://crinkly-
                majorie-dramatic.ngrok-free.dev/pages/glossary-and-faq.html"
71      },
        {
            "url": "pages/license-and-credits.html",
            "errors": 0,
            "alerts": 2,
76          "features": 1,
            "structural": 7,
            "contrast": 0,
            "errorItems": [],
            "alertItems": [
81            {
                "id": "h1_missing",
                "description": "Missing first level heading",
                "count": 1
              },
86            {
                "id": "noscript",
                "description": "Noscript element",
                "count": 1
              }
91          ],
            "contrastItems": [],
            "waveUrl": "http://wave.webaim.org/report?url=https://crinkly-
                majorie-dramatic.ngrok-free.dev/pages/license-and-credits.html
                "
        },
        {
96          "url": "pages/about.html",
            "errors": 0,
            "alerts": 2,
            "features": 1,
```

```
          "structural": 7,
101       "contrast": 0,
          "errorItems": [],
          "alertItems": [
            {
              "id": "h1_missing",
106           "description": "Missing first level heading",
              "count": 1
            },
            {
              "id": "noscript",
111           "description": "Noscript element",
              "count": 1
            }
          ],
          "contrastItems": [],
116       "waveUrl": "http://wave.webaim.org/report?url=https://crinkly-
              majorie-dramatic.ngrok-free.dev/pages/about.html"
        }
      ]
    }
```

Reading Age Analysis Results

```
1  {
     "pages": [
       {
         "file": "./pages/students.html",
         "wordCount": 514,
6        "fleschReadingEase": 69.1,
         "fleschKincaidGrade": 8.3,
         "smogIndex": 11.5,
         "colemanLiauIndex": 9,
         "automatedReadabilityIndex": 9.9,
11       "gunningFogIndex": 10.6,
         "daleChallScore": 7.1,
         "averageGradeLevel": 9.9,
         "textStandard": "8th and 9th grade",
         "difficultWords": 81,
16       "averageSentenceLength": 19,
         "readingLevel": "Plain English (High School)",
         "readingAge": "15-16 years"
       },
       {
21       "file": "./pages/glossary-and-faq.html",
         "wordCount": 81,
         "fleschReadingEase": 68.5,
         "fleschKincaidGrade": 6.5,
         "smogIndex": 10.3,
26       "colemanLiauIndex": 8.9,
         "automatedReadabilityIndex": 7.1,
         "gunningFogIndex": 9.1,
         "daleChallScore": 7.8,
         "averageGradeLevel": 8.4,
31       "textStandard": "8th and 9th grade",
         "difficultWords": 18,
         "averageSentenceLength": 11.3,
         "readingLevel": "Plain English (High School)",
         "readingAge": "15-16 years"
36     },
       {
         "file": "./pages/license-and-credits.html",
         "wordCount": 323,
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         "colemanLiauIndex": 14.2,
         "automatedReadabilityIndex": 44.2,
         "gunningFogIndex": 37.5,
46       "daleChallScore": 11.6,
         "averageGradeLevel": 31.6,
         "textStandard": "15th and 16th grade",
         "difficultWords": 80,
         "averageSentenceLength": 80.5,
51       "readingLevel": "Very Difficult (College Graduate)",
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56        "wordCount": 1922,
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          "fleschKincaidGrade": 9.9,
          "smogIndex": 11.7,
          "colemanLiauIndex": 9.7,
61        "automatedReadabilityIndex": 9.9,
          "gunningFogIndex": 10.6,
          "daleChallScore": 7.3,
          "averageGradeLevel": 10.4,
          "textStandard": "9th and 10th grade",
66        "difficultWords": 348,
          "averageSentenceLength": 16.9,
          "readingLevel": "Fairly Difficult (High School)",
          "readingAge": "17-18 years"
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71    ]
    }
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Cross-Browser Compatibility Results

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      "error": null,
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        {
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          "name": "Home font rendering",
          "status": "passed"
        },
        {
          "name": "About page title",
          "status": "passed"
        },
```

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            {
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                "status": "passed"
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            {
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                "name": "Students JavaScript execution",
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163        },
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168        {
           "name": "License & Credits page title",
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173          "name": "License & Credits navigation links",
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188        {
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203        },
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208      ]
       },
       {
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              {
228             "name": "Home CSS Grid",
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              {
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233             "status": "passed"
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              {
                "name": "Home CSS Variables",
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238         },
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    },
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    },
    {
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    {
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      "skipped": 0,
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}
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