

Title: *Exploring Web Development Variables: A Multi-Factor Study on User Experience and Accessibility in Educational Contexts*

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Abstract

This research explores five critical elements of web development that impact user experience, accessibility, and engagement. The five variables examined are: (1) color schemes and layout styles, (2) screen reader performance through semantic HTML, (3) page load speed and its influence on retention, (4) web form design and error rates, and (5) AI chatbot integration on resource-based websites. Each factor was tested through controlled experiments using web pages built with HTML, CSS, and JavaScript, combined with feedback and interaction from real users. This study provides actionable insights for web developers aiming to create inclusive and optimized digital platforms, particularly in educational contexts. Key findings support best practices promoted by organizations such as the W3C, Nielsen Norman Group, and Google.

1. Introduction

In the digital age, the quality of a website's design directly influences how users engage with information, access content, and complete tasks. Effective web development considers not just aesthetic appeal but also accessibility, usability, and performance. This research, composed of five targeted experiments, investigates the individual effects of specific web development variables on user experience. Each section involves building two variants of a webpage differing by a single factor, then testing these with real users to measure outcomes such as task speed, preference, satisfaction, or error rate. This project is also meant to develop the researcher's own skills in design thinking, user testing, and coding using HTML, CSS, JavaScript, and accessibility tools.

2. Project 1: Color Schemes and Layout Styles

Question: How do color schemes and layout choices affect user engagement on educational websites?

Two variations of a study-resource website were developed. Version A used a flat, minimalist layout with neutral tones, lots of white space, and sans-serif fonts. Version B featured a more visually dynamic style, including vibrant colors (blue, red, yellow), a bold sans-serif font, and

asymmetrical card layouts. Fifteen students, aged 14–17, were asked to browse both sites for two minutes and complete a short usability survey using a modified System Usability Scale (SUS).

Findings:

- 80% preferred the minimalist layout, stating it was easier to focus on content and visually calming.
- 20% found the colorful version more “fun” and attention-grabbing, but slightly overwhelming for academic tasks.
- Eye-tracking observations showed fewer distractions and faster comprehension in the minimalist version.

Implications: Minimalist design supports better focus in educational contexts, aligning with research by the Nielsen Norman Group (2021), which states that overly busy interfaces increase cognitive load and reduce comprehension.

3. Project 2: Accessibility and Screen Readers

Question: How do different web structures affect screen reader performance?

Two HTML pages with the same content but different semantic structure were created. Version A used semantic HTML5 tags (`<main>`, `<nav>`, `<article>`, `<section>`) and a correct heading hierarchy. Version B relied on `<div>` tags with few IDs/classes and incorrect heading order (e.g., jumping from `<h1>` to `<h4>`). NVDA (NonVisual Desktop Access) was used to test both, and feedback was gathered from two blind users and one low-vision user.

Findings:

- NVDA navigated Version A in 40 seconds, with clear navigation points.
- Version B took over 90 seconds and resulted in frequent misreads.
- Feedback emphasized the importance of ARIA roles and heading hierarchy for orientation and comprehension.

Implications: Semantic HTML not only improves accessibility for screen reader users but also enhances SEO and future-proofing. Developers often underestimate its role, despite guidelines from WCAG 2.2 and WebAIM.

4. Project 3: Page Load Speed and User Retention

Question: How does load speed affect user retention and satisfaction?

Two homepage versions were built: one optimized with Gzip compression, lazy loading, minified JavaScript, and WebP images; the other loaded large images (PNG), unminified scripts, and blocking CSS. Load speed was measured using Google Lighthouse. A group of 20 users browsed both and completed a survey rating their satisfaction and likelihood to stay on the site.

Findings:

- Optimized page loaded in 1.4 seconds and retained 85% of users for more than 15 seconds.
- Slower page took 6.3 seconds and saw a 55% bounce rate.
- 70% of users reported frustration with slow load times; only 15% noticed differences in visual quality.

Implications: Speed optimization is critical. According to Google research, every additional second of load time increases bounce rate by 32%. Performance must be prioritized in modern responsive web design.

5. Project 4: Web Form Design and Error Rates

Question: Does the layout of web forms impact the number of user input errors?

Two identical sign-up forms were tested: Version A used a single-column, vertically stacked format; Version B used a two-column format with side-by-side fields. Both contained 8 input fields (name, email, password, etc.). Ten students were timed filling out both forms, and errors were tracked (e.g., incorrect email format, missed fields).

Findings:

- Version A resulted in an average completion time of 52 seconds with 4 total errors.
- Version B had an average time of 68 seconds and 9 total errors.
- Users stated that the two-column layout was confusing, especially on mobile.

Implications: The results confirm findings from the Nielsen Norman Group (2022), which recommends single-column forms for better scanning and fewer input mistakes.

6. Project 5: AI Chatbot Integration and User Experience

Question: Does adding an AI chatbot improve user experience on a school resource website?

A school information site was created in two versions: one with and one without a chatbot powered by OpenAI's GPT API. Twelve students were asked to find three pieces of information (e.g., office hours, counselor contact) and then rate their experience using the USE Questionnaire (Usefulness, Satisfaction, Ease of use).

Findings:

- 75% of users found the chatbot-assisted version more helpful.
- Tasks were completed 30% faster on average using the chatbot.
- Some users preferred human-like interaction, while a few found the chatbot unnecessary for simple queries.

Implications: AI chatbots improve self-service efficiency but must be clearly integrated and not interruptive. As chatbots become more sophisticated, their role in education websites may expand further.

7. Conclusion

This study highlights how individual web development decisions significantly impact user engagement, usability, and accessibility. Minimalist interfaces aid focus, semantic HTML improves accessibility, optimized speed reduces bounce rates, simple form designs minimize errors, and AI chatbots enhance guidance. These insights can help both novice and experienced developers create more effective digital experiences. For future research, scaling the user base and using analytics tools (e.g., Hotjar, Google Analytics) could provide deeper insights. Exploring voice interfaces, personalization, or multilingual access would also expand the scope of inclusive design.

8. References

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