Disability Studies in Computer Science:  
A New Pedagogy for Web Design

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1 Introduction

Integrating disability studies into computer science can improve pedagogy. In this paper, I’ll examine this claim, taking introductory web design as an example.

The discussion will proceed as follows. After looking at the importance of the world wide web, I’ll mark a distinction between access to the web and access to web content. We’ll then examine the two key aspects of access to web content, namely, the ability to interpret individual documents and the ability to navigate the web. We’ll see that there is a dual nature to providing accessible web content: accessibility is not difficult to achieve (which is good), but it must be done voluntarily by web authors (which is not so good). I’ll argue that by integrating disability studies into a course in web design, we can provide web authors with the motivation and skills to produce accessible web content.

2 The World Wide Web

Since its inception by Tim Berners-Lee in 1990, the World Wide Web has rapidly become our society’s most important communications medium. I don’t think this is overstating the case. Take the recent presidential election (please!). If you followed the campaign via the web, you could tap into all

the traditional media, and do it asynchronously and alocally—e.g., you could watch the political television commercials everyone was talking about, even if they weren’t being broadcast via television in your part of the country. Further, you could access detailed position statements over the web that weren’t otherwise available. And you could check out the “blogs” everyone was talking about.

But I haven’t come here to praise the web, so even if it’s not the most important communications medium, it is nonetheless very important. At least it’s important to the extent that someone who doesn’t have access to the world wide web is less well off than someone who does—and in the case of the recent election, I think this became very clear. It was extremely difficult to be well-informed without resorting to the web, and to a large extent this was because much of the discourse assumed that interested citizens had web access. Newspapers apparently don’t like to waste valuable advertising space by printing detailed (read “boring”) position statements when an interested citizen (or “wonk”) can simply look up the information on the web.

So, the web is important.\footnote{Others have made the point (see, e.g., Blasiotti et al. \cite{2}) that the Internet and World Wide Web are important organizing and communications tools both for people with disabilities and for the disability studies community. (Note that I don’t mean to imply that these are disjoint classes.) Here, I want to make the further point that access to the web has become a necessity for engaged citizens \textit{simpliciter}. Ultimately, my argument is that just as the web is important to disability studies, disability studies is important for the web.} Further, despite talk of a “digital divide”, it is available to most of the population through access points in public libraries. And thanks to the Architectural Barriers Act, the Access Board, and the American with Disabilities Act (and, of course, to lawsuits by concerned citizens), most public libraries are physically accessible to disabled persons. For a specific class of persons, however, just gaining access to a computer terminal does not automatically provide access to web content. I’m speaking, of course, of visually impaired computer users.\footnote{This is true for other classes of disabled persons as well, but my focus in this paper is on the visually impaired.}

Before continuing, it’s useful to make a distinction between \textit{access to the world wide web} and \textit{access to web content}. For the sake of argument, I’m going to assume that there are no physical barriers preventing visually impaired users from using a computer. Hence, we’ll assume that each visually impaired person has access to a computer equipped with screen-reading software and headphones (I’m thinking of a public library here). Thus, ideally, each visually impaired person has access to the world wide web. Whether or not this ideal situation obtains, however, is beside the point; access to the
world wide web is a necessary but not sufficient condition for gaining access to web content. Let’s explore why this is the case.

The world wide web is simply an infrastructure for information. The key aspect of this infrastructure is that it supports hypertext, that is, the seamless integration into a coherent whole of documents that might physically be completely disparate. The Hypertext Markup Language (HTML) and the Hypertext Transfer Protocol (HTTP) provide for the structuring of information, both within a single document and as an interconnected web of documents. To gain access to web content, one must have access to the world wide web (via a computer with an internet connection and browser) and the ability to interpret individual documents and to navigate the web of documents. Just as it’s possible to make the world wide web itself inaccessible through physical barriers, it’s possible to make the content of the web inaccessible through the way information is structured. This inaccessibility of content is what I’ll be talking about today.

3 An initial connection to disability studies

Before discussing some of the technical aspects of making web content accessible, however, I want to make an initial connection to the role I think disability studies can play in computer science education, at least with regard to teaching students how to implement websites. As I indicated in opening, the world wide web has become an important component of contemporary living. And while parts of it may be subject to government regulation, it’s pretty much a “wild west” situation out there—one reason being that cyberspace isn’t located in any particular physical location and doesn’t respect the normal political boundaries.

Compare the situation in cyberspace to the situation in normal space. In normal space, the government has control over large portions of the infrastructure. While the government may not be able to ensure that every building in the USA is accessible to persons with disabilities, it does have the power to ensure that roads and sidewalks are constructed in a way to maximize accessibility through curb cuts, talking signposts, etc. And, of course, this accessible infrastructure leads not only to government buildings (which, by government mandate, must be accessible), but to private build-

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3'Document' is being taken here in a broad sense to include displayed video, sound, etc. (It makes sense to refer to a 'document' since the web page itself, which houses the various media, is itself a plain text document in the traditional sense.

4The extent to which this is actually accomplished, however, is a different story.
ings as well. Thus if a private citizen chooses to make his or her building accessible, disabled persons can use the accessible infrastructure to reach the facility.

On the web, there is no corresponding infrastructure for the government to regulate. There are simply HTTP connections between resources. As with federal buildings, the government can mandate that federal websites be accessible to the visually impaired—it has done this with Section 508 of the Rehabilitation Act.\textsuperscript{5} But the government has no ability to construct an accessible infrastructure to set the “social tone”, for the simple reason that there isn’t anything there to be constructed.\textsuperscript{6} So in comparing regular space with cyberspace, it’s clear that the effectiveness of accessibility via legislative mandate is severely curtailed in the latter.

To wax evangelical, this is a situation in which “salvation lies within”. The only way to make website accessibility a priority for webmasters is to raise within them the conviction that it is the proper thing to do. External mandates won’t do it. So how do we establish such a conviction? This is where disability studies fits in. A good understanding of the importance of accessibility and the extent to which it can transform peoples’ lives can provide the motivation to implement accessible websites.

Of course, a desire to do the right thing only goes so far—especially in a situation like this where contravening the right carries no penalty. Fortunately, implementing accessibility is not all that difficult, is not very expensive, and may in fact have salutatory consequences beyond the assistance it renders to the visually impaired. There’s good reason to think that accessible website design is superior design for purposes that extend way beyond accessibility.

We’ll explore these points in detail later. First we need to examine the concept of accessible web content.

\section{Accessible web content: interpreting documents}

I said earlier that accessibility to web content has two necessary components:

\begin{enumerate}
\item the ability to interpret individual documents
\item the ability to navigate the web of documents.
\end{enumerate}

\textsuperscript{5}More precisely, this is Section 508 of the Rehabilitation Act (29 U.S.C. 794d), as amended by the Workforce Investment Act of 1998 (P.L. 105-220), August 7, 1998.

\textsuperscript{6}An important aspect of the ubiquity of, e.g., curbcuts is that it modifies our expectations of what “normal” space is like and the means by which it is “normally” navigated.
I’ll discuss the first component in this section, holding the second for the next section.

It may strike you that the first component is too strong a requirement. For example, suppose the web document currently loaded into my browser is a hypertext version of *Being and Time*—on a strong sense of ‘interpret’, not a lot of people (and I don’t exempt myself here) are going to be able to access its content. So clearly I don’t want to mean ‘interpret’ in a strong hermeneutical sense.

One way to get a handle on ‘interpret’ is to invoke a kind of *ceteris paribus* clause, and say that a particular web page $W$ is accessible when it is such that given visually impaired person Victor and non-visually-impaired person Ned of the same level of intelligence, Victor is able to understand the page to the same extent as Ned.

If you think about it for a minute or two, you’ll realize that there are so many problems with this definition that you’ll wonder why I even bothered to propose it. (Actually, it will be helpful in the next section.) So instead of trying to clarify it, we can come up with a precise sense of ‘interpret’ that is independent of the intelligence of agents Victor and Ned. This is to tie interpretation to an ability to understand the *syntactic structure* of a document. Even if the content of *Being and Time* is difficult to extract hermeneutically, it’s not too much to expect that one can identify particular syntactic elements of the text (e.g., headings, subheadings, paragraphs, lists) and understand how these are related to each other at the level of syntax (e.g., which heading goes with which set of paragraphs; which list items belong to which list, etc.). In fact, one might argue that this task requires no intelligence at all, seeing that one could easily write a computer program to perform this exact task. As a computer scientist, this is good enough for me, so I’ll accept this syntactic sense of ‘interpret’.

Here’s an example to demonstrate why this definition is strong enough to do the job we’ve assigned it. Consider the following list:

- Ralph Nader
- David Cobb
- Gus Hall

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7 Is this then *too weak* a sense of ‘interpret’? That’s an interesting question, but it lies beyond the scope of this paper. My primary purpose here is to encourage the production of web content that can be easily parsed by screen-reading software, so I’m not going to worry about setting the bar too low. On the plus side, if we set the bar low, then clearly we’re not asking too much of web content providers when we encourage them to provide accessible content.
Here are two ways to generate this list in HTML. Both methods yield text displayed in a manner identical to that above. 8

```
<p>&bull;&nbsp;&nbsp;Ralph Nader</p>
<p>&bull;&nbsp;&nbsp;David Cobb</p>
<p>&bull;&nbsp;&nbsp;Gus Hall</p>

<ul>
  <li>Ralph Nader</li>
  <li>David Cobb</li>
  <li>Gus Hall</li>
</ul>
```

Examining the HTML directly, we see that the first structure is a set of three paragraphs, in which each paragraph begins with three special characters (as indicated by the HTML entity codes beginning with an ampersand and terminating in a semicolon). The syntactic information we can glean from this is that these are three distinct paragraphs. Presumably, the text each contains is somehow related; we infer this from their contiguity. But whether they are closely related, as elements of a list, or more loosely related, as this paragraph is related to the one that follows, we cannot infer directly from their syntactical markup.

The second structure is clearly a list. The `<ul>` and `</ul>` tags indicate the beginning and end of an unordered list. The `<li>` and `</li>` tags mark the beginning and end of each list item. We know that each item is a member of the same list not just because of their relative locations, but because they are clearly contained in the same list structure.

Although both ways of marking up the text yield the same visual display, it’s clear that marking up a list as a list preserves information that the paragraph markup does not. Further, if we were to use a computer program to parse the HTML files, the list markup would provide the program with information it could not glean directly from the paragraph markup. One way to mark this distinction is to say that both fragments of HTML yield the same presentation—viewed in a browser, they are identical. The second fragment, however, mirrors more exactly the logical structure of the text.

Here’s another example. A book title (e.g., *The Difference That Disability Makes*) and emphasized text (e.g., “webpages must be accessible”) are

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8For verification of this claim, please refer to the pages on my website related to this paper. You can find them at

http://academics.hamilton.edu/computer_science/brosmait/talks/110504/.
both traditionally displayed in italics. In other words, they have the same presentation. But note that they are different ontologically—the first is a title while the second is an emphasized phrase.

In authoring a web page, the two phrases could be marked up using `<i> </i>` tags, which indicate italicized content. This would give them both proper presentation on the web page. A better solution, however, would be to respect their difference and mark the former with a pair of `<cite> </cite>` tags (indicating a citation) and the latter with a pair of `<em> </em>` tags (indicating emphasis). This alternative markup would give them the proper presentation as italicized text while at the same time reflecting much more clearly the difference in content.

The moral of this story is that it’s important to clearly separate content from presentation. Further, it turns out that this is a useful thing to do whether or not one’s concern is providing accessible content. For instance, one might want to mark visually the difference between a title and an emphasized phrase by, e.g., making the title slightly larger or in a different font. If both title and emphasized text are marked up with `<i> </i>` tags, this is not going to be very easy to accomplish. If the original author keeps in mind a strong content/presentation distinction, however, and respects this distinction in marking up a web document, it will be much easier to do website maintenance. (All the author will need to do is write different style instructions for the two tags.)

All this is as little followed in web design circles as it is well known. One reason is that beginning web authors are mostly interested in simply getting their documents to display on the web. (After that, they tend to be interested in including all the flash widgets that all the kids are using.) For beginners, there are usually enough problems to be overcome (e.g., saving files in the proper format, getting the files uploaded and made public on the server) that as long as the document looks correct, a student is satisfied. Many of them feel, understandably, that if you can’t tell the difference between `</cite>` and `</em>` when you look at your page on the web, then what’s the difference?

This is where having an accessibility model of web access is very helpful. If students approach marking up their documents from an accessibility standpoint, it’s easier for them to keep in mind that even if you can’t tell the difference between `<cite>` and `<em>` visually, there’s nonetheless a big difference. With a strong content/presentation distinction in hand, it is much easier to teach students to use a markup language to mark up the logical structure of a document, and to leave the presentation features to a stylesheet.
Placing an emphasis on accessibility provides students with a good reason to separate content from presentation. It’s easy to imagine screen reading software increasing in loudness when reading text marked up with `<em>` tags, but it’s not so clear what you’d want it to do when encountering a new `<font>` tag. (Does the font change signify change in emphasis? Does it signify a book title? Does it signify a heading? Does it have no logical significance at all in the document?) If students are familiar with the idea that their web content may be accessed non-Visually, and are motivated to mark up their content accordingly, they will produce better web content. By incorporating some disability studies content into web design courses, we can provide both the motivation to write accessible pages and a useful model for authors to keep in mind as they mark up their documents.

To summarize the main point of this section: we can make individual web documents accessible by marking them up in such a way that the logical structure of the document is preserved by the markup. While understanding the content of a document may depend upon individual intelligence (whether for visually impaired or non-Visually-impaired web surfers), well-done markup will allow both visually impaired and non-Visually-impaired web surfers to interpret its logical structure equally.

5 Accessible web content: navigating the web

Having discussed the interpretation of individual web documents, we now turn to the second necessary component of accessible web content: the ability to navigate the web of documents.

As mentioned earlier, web documents are navigated by following hyperlinks. These are marked up in HTML by using an anchor tag, represented as `<a>` and `</a>`. The content of the tag (whatever is in between the `<a>` and the `</a>`) becomes a “clickable” hyperlink. When clicked, your browser will display the linked-to content. (Technically, the browser displays whatever content is specified by the Uniform Resource Locator (URL) which is a value of the `href` attribute of the anchor tag.) For example,

```html
<p>
Brian Rosmaita is currently the treasurer of the <a href="http://cs.hamilton.edu/~sfmm/">Society for Machines and Mentality</a>, an international scholarly organization.
</p>
```
If the above paragraph were included in a web document, the text “Society for Machines and Mentality” would be a hyperlink. If you activated the hyperlink (e.g., by clicking on it), your web browser would attempt to load the web page located at the URL \url{http://cs.hamilton.edu/~sfmm/}, which (as you’ve probably guessed) is the homepage for the Society for Machines and Mentality.

As with the other aspects of web markup we discussed earlier, it’s clear that in HTML we have a purely syntactic means for identifying hyperlinks. So can the problem of defining accessible web navigation be solved in the same way as that of specifying equal-access document interpretation?

Unfortunately, it cannot. To see why this is so, let’s recall our motivation for rejecting a stronger sense of “interpret” in the previous section. It was that if we didn’t restrict interpretation to merely an understanding of the syntactic structure of the document, it would be difficult to quantify precisely what “equal access” would mean, due to the differing levels of intelligence of persons accessing the document.\footnote{Note that this applies equally to both visually impaired and non-visually-impaired users. It’s not a judgement about the relative levels of intelligence of the two classes of people—it’s just a simple observation based on the fact that when faced with, e.g., a chapter of \textit{Being and Time}, some people are going to “get it” (maybe!) and some aren’t.} It would be completely unreasonable to require the author of \textit{Being and Time} only to post web pages that could be understood by the general public. (For one thing, Heidegger probably thought that he was expressing his ideas in the clearest form possible already!) But while it would clearly be an undue burden on authors to write web pages such that all possible readers could understand their contents, we noted that it doesn’t appear to be an undue burden to ask authors to mark up pages in such a way that the mark-up used reflects the logical structure of the document. That way, even if a reader didn’t understand each paragraph in a section headed, e.g., “The Ready-to-Hand”, the person could at least recognize that the sequence of characters ‘The Ready-to-Hand’ is being used as a section heading, that the paragraphs following are related to that heading, and so on throughout the document.

The problem with adapting that solution here is that the syntactic information associated with the markup of a hyperlink doesn’t reveal much beyond the fact that it’s a hyperlink. So we’re going to need a stronger sense of ‘interpret’ in this case.

When you think about it, though, we shouldn’t expect that too much intelligence is required in interpreting a hyperlink. After all, in examining a link, all you really need to know is where it will take you. You need not realize the full implications of the link. For example, the knowledge that a
link will take you to the text of *Being and Time* will allow you to distinguish that link from others on a particular web page. Whether you personally will be intellectually well-rewarded by following the link is an entirely different matter.

What this amounts to, then, is that hyperlinks should be clearly marked with text indicating what each is a link to. While this information is absolutely essential if you are going to perform navigation in any meaningful sense, more is not needed.\textsuperscript{10} So unlike the individual document situation, where it made sense merely to require an understanding of the syntactic structure of a document, in this case we’re forced to require understanding of the semantic content of a link, i.e., an understanding of what it’s a link to. We can quantify this by adapting the *ceteris paribus* clause we considered in the last section: given visually impaired person Victor and non-visually-impaired person Ned of the same level of intelligence, a set of web pages are accessibly navigable if Victor and Ned can navigate them with the same level of competence.\textsuperscript{11}

It may strike you that this has been much ado about nothing: surely, all this amounts to is that a reader has to be able to understand the contents of the HTML anchor tag. To a certain extent, this is true; but only to a certain extent. Consider the following HTML fragment:

\begin{verbatim}
<a href="http://150.209.91.20/~sfmm/">click here!</a>
\end{verbatim}

Syntactically, it’s clear that it is a hyperlink. But what is it a hyperlink to? Neither the content of the anchor tag (“click here!”) nor the URL (http://150.209.91.20/~sfmm/) provide any clue.\textsuperscript{12} This obviously makes navigation difficult.

Making the content of a single document accessible is merely a matter of writing HTML markup that respects the logical structure of a document. This isn’t conceptually very difficult, but it does require some effort on the

\begin{footnotes}
\item[10]Information about what further links may be reached from this link can be gained simply by taking the link and then finding out. Thus as long as the links on the current page are clearly marked, meaningful navigation is possible.
\item[11]This obviously allows for a wide range of variability in how hyperlinks are marked—and appropriately so, since the quality of web content itself is widely variable depending upon the competence of the author (speaking here of pure semantic content independent of any type of markup for posting on the web). The key aspect is that on poorly written web pages, both Victor and Ned will have *equal* trouble in navigation.
\item[12]In fact, this is a properly formed hyperlink to the homepage of the Society for Machines and Mentality. It may be instructive to compare this anchor element to the one on page 8, which links to the same resource.
\end{footnotes}
part of web authors. Making navigation accessible requires a higher order of creativity.

Fortunately, HTML itself has a feature to assist this. The anchor tag can take a `title` attribute in which one can include text to describe the link. For example, the following is currently on my homepage:

```html
<a title="History of the pink triangle symbol"
   href="http://www.enqueue.com/ria/triangles.html">
   <img src="img/pink.png" longdesc="img/pink.txt"
      alt="An inverted pink triangle" /></a>
```

Here the content of the anchor tag isn’t text at all, but is a picture. (The `alt` attribute of the `<img>` tag provides text describing the picture; it is required in HTML 4.) By specifying a value for the anchor’s `title` attribute, it’s possible to provide a meaningful description of where the link leads, even though anchor element contains no text.

Unfortunately, this clearly requires more effort than correctly marking a document’s syntax. But this is a place where I think disability studies can help. By considering the situation of visually impaired computer users, web authors are provided with a useful model of one type of surfer who might encounter their content, as well as a reason to put forth the extra effort to make their web content accessible.

6 Aids to Salvation

As I indicated earlier, creating accessible web content is a situation where “salvation lies within”. It’s up to the individual content provider to take the time and effort to make web content accessible. As you’ve gathered in reading this paper, this is largely a matter of exercising common sense in doing the markup on a document. Nonetheless, it is still effort above

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A comment about ‘requirements’ on the web: the world wide web was designed to make it easy to post content. Therefore, most browsers are very tolerant in reading HTML markup. While there is a strict syntax defined for HTML, it is not enforced: if a page contains malformed HTML, the browser will go ahead and display it anyway. So unlike a programming language, for which syntactically malformed code will not execute, you can write malformed HTML and it will still be displayed in a browser and will most likely be readable. Thus while the `alt` attribute of an `<img>` tag is required by the definition of the language, it may be left out and your page will display just fine in a browser—the image will just be meaningless to a visually impaired computer user. Of course, poorly written `alt` text may leave a visually impaired user just as clueless. So, as with anchor tags, writing effective `alt` text requires creativity on the part of an author.
and beyond the default option of doing nothing. Further, we’ve noted that enabling accessible navigation requires some creativity on the part of an author—not much, but again it is still effort above and beyond the default option.

Luckily, there are resources available to assist web authors. The World Wide Web Consortium (W3C) was founded by Tim Berners-Lee in 1994. Its purpose is to “lead the World Wide Web to its full potential by developing common protocols that promote its evolution and ensure its interoperability” [6]. In practice, this means issuing technical specifications for the Web’s infrastructure.\(^\text{14}\)

Of particular importance here is what the W3C identifies as the first of its long-term goals for the web:

\textit{Universal Access:} To make the Web accessible to all by promoting technologies that take into account the vast differences in culture, languages, education, ability, material resources, access devices, and physical limitations of users on all continents [6].

To promote this goal, the W3C supports the Web Accessibility Initiative, which has issued a set of Web Content Accessibility Guidelines (WCAG 1.0)[7]. These suggest techniques to emulate (or avoid!) in marking up web content.

Ultimately, however, it is up to the individual web author to ensure accessibility.

7 Curricular Transformation

In the standard approach to teaching web design, accessibility is treated as an “add-on”—something extra that one can do, but ancillary to the primary task of designing visually attractive web pages. Further, some of the requirements for accessibility conflict with common web design techniques (e.g., the use of tables for page layout). Thus students view accessibility as something you go back and throw in at the end after you’ve done the important stuff—if you bother to do it at all.

Instead of teaching accessibility as an “add-on”, I propose that it be brought front and center and made the focus of a first course in web design. All aspects of web design should be taught from the standpoint of how they contribute to accessibility. This may seem odd, since the visually impaired

\(^{14}\text{See Seelman [5] for a brief account of the history and development of the W3C.}\)
are clearly a minority of those viewing web pages, but there are many advantages to this approach. We’ve already seen that it promotes a strong motivation for separating presentation from content, which makes website maintenance easier.

Further, while many people think of the web as an inherently visual medium, web surfing is increasingly being done using alternate modalities. We don’t want people surfing the web via cell phone while driving to be looking at a monitor and pointing and clicking—clearly, we want them to surf by listening and speaking commands. So as the web continues to evolve, a strong separation of content and presentation will become even more important.

So far in this paper, I’ve mentioned integrating disability studies into the course content as a motivating factor for implementing accessibility. My idea is that if students gain an empathy for the visually impaired, they will be motivated to take the extra effort required to implement accessible web content. And I believe that this will be effective. But another important aspect of integrating disability studies (rather than just sad stories about visually impaired web surfers) is to provide students with an understanding of how the “abled” world tends to impose upon the disabled what it thinks is good for them. As Simi Linton has pointed out,

> The scholarship and curriculum practices housed in academic institutions play a significant role in the perpetuation of a divided and unequal society. The academy has only just begun to examine how its paltry and lopsided vision of disability compromises the knowledge base. [3]

It might be easy to impose a syntactic regime upon students. We could, for example, require students to write syntactically valid HTML (as verified by a syntax-checking program) and take points off for document markup that doesn’t respect the logical structure of the document. (And these are both good things!) Ultimately, as we’ve seen, accessible content requires some creativity on the part of web authors. (Which is good—we all want to encourage student creativity.)

By integrating disability studies, rather than simply imposing a view of accessibility on students, I hope to remedy our compromised knowledge base. In exercising their creativity to create accessible content, students need to keep in mind the needs of users. What do visually impaired computer users find helpful as text describing hyperlinks? What kind of text is helpful for describing images?

15This is a recurring theme, for example, in Michalko’s *The Two-in-One* [4].
An advantage to working on the web is that visually impaired computer users are there with you in cyberspace. They can be sought out for assistance in this regard. Rather than being simply consumers of accessible content, they can (and should!) be consulted in its creation.

8 Conclusion

In this paper, I’ve argued for curricular transformation in computer science: integrating disability studies into introductory web design. By making accessibility the organizing principle of a course, rather than an ancillary topic, I think we can more effectively teach students to become competent web designers.

References


