Tools for Creating Accessible, Tiered, and Multilingual Web-Based Curricula

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What is This?
Abstract
Although inclusion has provided access to the general education classroom for students with disabilities, there are significant questions about whether these students have gained full access to the curriculum. To design curricula for diverse learners, designers must have a clear picture of the obstacles and barriers that some students encounter. This article describes a design process that was used to create a web-based tool that allows teachers to create tiered web-based curricula for their classroom without any programming knowledge. The goal is to allow educators to quickly and easily develop digital instructional materials that are simultaneously accessible, flexible, and engaging for diverse learners such that supports are embedded into the curriculum for all students to use as needed. This article describes the steps, and missteps, along an instructional design journey.

Keywords
accessible curriculum, instructional design, tiered text, web-based instruction

Classroom instructional practices have always been reflective of the availability of the technologies of the day. For much of human history, knowledge was transmitted orally. The invention of the printing press increased the use of knowledge that was written down. Over time, reading became more important than oral recitation (Cuban, 1986).
Textbooks became the core curriculum in American education in the 18th through 20th centuries. Although textbooks were an important source of information and served to codify the curriculum in years gone by, they represent a one-size-fits-all approach to curriculum and instruction (Allington, 2002; Cibrowsi, 1993) that appears considerably inflexible for meeting the needs of diverse 21st-century learners. Arguably, a significant portion of the achievement gap can be attributed to the ability of students to access and engage with information presented in textbooks after third grade when the focus of instruction is on learning from text.

Teachers have always made instructional materials for their classes, but it was not until schools installed copy machines in the 1970s that teachers had ready access to tools that allowed them to easily customize instruction. By the end of the 20th century, when educators began to integrate the World Wide Web into instruction, new possibilities began to emerge regarding the availability and use of digital instructional materials.

A key characteristic of 21st-century education is that classrooms are more diverse than ever (“Diversity in the Classroom,” 2010; National Center for Educational Statistics, 2010). If one of the core principles of universal design for learning (UDL) involves proactively valuing diversity (Edyburn, 2010), then why are there not more examples of technology tools that serve to differentiate and support diverse learners?

This article describes a design process that was used to create a web-based tool that allows teachers to create tiered web-based curricula for their classroom without any programming knowledge. The goal is to allow educators to quickly and easily develop digital instructional materials that are simultaneously accessible, flexible, and engaging for diverse learners such that supports are embedded into the curriculum for all students to use as needed. Emphasis is placed on the insights gained from this instructional design process to help other professionals think about their response to academic diversity.

**Foundations**

The project originated from a variety of technology integration workshops for in-service teachers. Among the tools that were introduced were websites that provided information at multiple levels (see Table 1 for a list of examples). As teachers became more aware of UDL (Rose & Meyer, 2002), they recognized that these types of tools illustrated the universal design principles of multiple means of representation and engagement.

Teachers responded positively to the instructional design of tiered websites. Moreover, as they used these digital resources in their classrooms, they discovered that the websites with tiered information were a valuable and effective means of supporting diverse students in inclusive general education classrooms. Often this led to an increased appetite for additional tiered websites.

Despite the apparent value of digital tiered instructional materials, it became apparent that these design principles were not commonly found in educational websites. Perhaps it was the repeated exposure to this core set of websites that stimulated the idea, “What if there were a tool that would allow teachers to create webpages that embed accessibility supports and provides access to tiered content?” Recognizing the range of reading skills in every classroom, why not design reading materials that provide readers with options for manipulating text size, font, background colors, and cognitive difficulty with audio and second language supports? What if teachers could have a tool that would allow them to make accessible tiered talking webpages quickly and easily? Thus began the design and development of a tool that would allow busy teachers who recognize the diverse needs of their students but did not have adequate time, resources, or support, to create web-based supported reading materials. The information that follows describes the steps, and missteps, along this instructional design journey.

**Understanding Diverse Students to Influence Instructional Design**

It is common to discuss diverse learners as if they were a homogenous group. However, to design curricula for diverse learners, designers must have a clear picture of the obstacles and barriers that some students encounter. As the types of students in a classroom that struggle with grade-level reading
assignments were considered, the following characteristics emerged:

1. Students who would like to learn more about a topic but whose reading fluency skills were so poor they could not access the meaning of the text because all their cognitive energy was being used for decoding
2. Students who struggle but would not typically be identified as needing reading support
3. Students with mild disabilities who were known to need text to speech support
4. Students who are blind and needed to access text using a screen reader
5. Students with low vision who need to adjust text size to comfortably see the text
6. Students whose first language is not English who struggle with vocabulary and the complexity of language
7. Advanced learners who want to know more

The instructional designs were informed by an understanding of the special needs some groups of students routinely encountered as they sought to interact with printed instructional materials. This information was subsequently used to create a diversity blueprint (see Table 2) to understand differences in a meaningful way and establish design principles for utilizing the power of technology to meet the needs of diverse students. Identifying a primary beneficiary allowed the creation of a framework for measuring the outcome of the design feature by focusing on the performance of the targeted students. However, the argument has been made (Edyburn, 2010) that when interventions are truly characteristic of UDL design, the number of secondary beneficiaries is always larger (e.g., many, everyone in the class) than the number of targeted students (e.g., individual, small group).

### Identifying the Core Components

Inspired by the potential of tiered websites and the diversity blueprint, which was created to understand the special needs of struggling students, two key components that would be needed in web-based curricula were identified: accessibility features and tiering.

### Accessibility Features

Much is known about accessible design, but often this information is very technical and involves a great deal of advanced training to fully understand (Chisholm & May, 2008; Henry, 2007; Slatin & Rush, 2002). Therefore, a key insight was that several accessibility features could be built into a webpage template. Consequently, teachers would have no need to spend time on these very technical interventions. Three accessibility design features were integrated into the webpage template so that reading supports would be available to every student on every page: cascading style sheets (CSS), text-to-speech, and language translation.

An important advance in web design is the separation of content from style. This is accomplished by using both HTML and CSS. Content is included in the HTML file but is adjusted by the user by applying different style sheets. As a result, the reader is able to alter the text size, background

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**Table 2. Aligning Instructional Design With Diversity Characteristics to Create a Diversity Blueprint**

<table>
<thead>
<tr>
<th>Design feature</th>
<th>Primary beneficiary</th>
<th>Secondary beneficiary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Web-based curriculum created in accordance with accessibility standards</td>
<td>Students who are blind may access the information with a screen reader</td>
<td>Any student can access the information by using a web browser</td>
</tr>
<tr>
<td>Physical characteristics of the text should be alterable by the reader</td>
<td>Students with low vision</td>
<td>Any student who feels the need to adjust the text because of glare, tiredness, or undiagnosed vision problem</td>
</tr>
<tr>
<td>Text should be tiered to accommodate different interests and reading abilities</td>
<td>Students who lack background knowledge, students who struggle to read grade-level text, advanced students who would like to be challenged</td>
<td>All students can seek the level that is of most interest and appropriately challenging for them</td>
</tr>
<tr>
<td>Reading materials that offer choice enhances motivation and engagement</td>
<td>Reluctant readers with low motivation and interest to engage in reading</td>
<td>All students benefit from the opportunity to choose their reading materials</td>
</tr>
<tr>
<td>Audio support should be available for readers who need this support</td>
<td>Students with low decoding skills and poor fluency may benefit from hearing the information read aloud</td>
<td>Any student who would like the opportunity for a media shift that transforms a reading task into a listening activity</td>
</tr>
<tr>
<td>Text should be available in additional languages for English language learners</td>
<td>Learners whose first language is not English</td>
<td>Any student who would like the opportunity to read the information in a second language</td>
</tr>
</tbody>
</table>
color, and font style. Readers interested in experiencing the value of a personalized style sheet are encouraged to visit Readability (https://www.readability.com/bookmarklets/).

Historically, text-to-speech products have been considered assistive technologies. However, new tools have been developed that allow adding speech to any application or webpage. vozMe (http://vozme.com) is one such tool and has frequently been used as an accommodation for struggling readers by teaching them to copy and paste information into the web-based interface and then using the online web application to convert the text into audio that can be heard immediately or saved as an MP3 file. It was discovered that the developers make their application programming interface (API) freely available to anyone (http://vozme.com/webmasters.php?lang=en). As a result, their API code was embedded in the webpage template to send text from the webpages to the vozMe speech engine so that anyone could have the text on any page read to them. However, this design principle fails to meet the needs of blind users since audio is not provided for menus and thus necessitates the continued use of a screen reader for users who are blind.

Finally, multilingual texts are not readily available in most schools. Therefore, few students whose first language is not English are provided with appropriate access to the curriculum. Therefore, it is essential to make text accessible to students whose first language is not English. Similar to vozMe, teachers and students have been using Google Translate (http://translate.google.com) and Babel Fish (http://babelfish.yahoo.com/) as an accommodation for several years. That is, students could take text they could not understand in English, paste it into the web-based interface, and read it in a second language. Although the translation is never perfect, it is important to consider that online language translation gives far more support than the vast majority of monolingual teachers can provide. Google’s Language Translation API (http://code.google.com/apis/language/) was also embedded in the webpage template to send text from the webpages to their language translation engine so that any user could have second language text in more than 50 languages available on demand.

Tiering

Textbooks represent a one-size-fits-all approach to the curriculum because of the limits of traditional printing and publishing. Many factors are associated with the complexity of a text that can affect an individual’s understanding of the material. One of the key design principles associated with tiering is that it represents a methodology for exploring how to make text accessible at “just the right level” for diverse students. Recall Goldilocks’s efforts to find the circumstances that were “just right.” Therefore, it seems appropriate to use this metaphor to ask 21st-century learners to approach interactive learning materials as Goldilocks to find the level that is “just right” for their learning.

Copyright restrictions prevent information from textbooks to be made accessible in digital format for every student. As a result, it is emphasized that teachers seeking to create accessible digital instructional materials will need to utilize open-source information that has more flexible copyright options. Readers interested in knowing more about alternatives to traditional copyright are encouraged to visit the Creative Commons (http://creativecommons.org/licenses/).

The curriculum design process begins by asking teachers to select a topic for their unit. Next, they are asked to define how many subtopics will be covered as part of the unit. Finally, they must determine how many tiers (i.e., levels) they will include in their design.

To assist teachers in locating appropriate information to support their unit, they are provided with links to a series of web resources that offer text and resources that may be useful to include in their unit. Five particularly valuable tools we use to help teachers tier content are outlined in Table 3.

Finally, online readability tools (http://www.usingenglish.com/resources/text-statistics.php) are demonstrated as well as how to calculate readability within Microsoft Word. Teachers then spend some time working on their unit by creating tiered text for each of their subtopics. Obviously this part of the process is labor-intensive. However, there are significant dividends that will reward their curriculum design efforts.

**Tactic 1: HTML Workshops to Create Webpages**

Convinced that an accessible webpage template would be well received by busy teachers, two all-day workshops in a Midwestern state and one all-day preconference workshop at a national conference were offered on the topic of creating accessible, tiered, talking webpages. The goal was to provide a series of HTML templates and an open-source HTML authoring program (http://kompozer.net/) to allow teachers to create accessible, tiered, talking webpages. However, at the end of each 6-hour workshop, out of 20 participants, there were usually only 2 participants who were able to successfully complete the process and publish a working webpage that could be installed on their school’s web server.

**Lessons Learned**

Although the use of templates was helpful in allowing teachers who knew nothing about HTML to create webpages, there was simply too much background information to cover. This information included discussion of file formats, introduction to HTML and CSS, as well as instructions for using the HTML editor. Among the problems that required
Table 3. Selected Resources Useful for Locating Information for Tiering Instructional Content

<table>
<thead>
<tr>
<th>Resource</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>42explore</td>
<td>Provides a text-based introduction to hundreds of topics at the beginning and advanced level. Includes extensive web links that have been vetted by teachers and library media specialists. Also, includes a list of core vocabulary related to the topic.</td>
</tr>
<tr>
<td>Wikipedia</td>
<td>A comprehensive open-source collection of articles.</td>
</tr>
<tr>
<td>Simple Wikipedia</td>
<td>A special version of Wikipedia where each article is written in simplified English. These articles are ideal for young children, struggling readers, English language learners, and students with cognitive impairments.</td>
</tr>
<tr>
<td>KidsClick!</td>
<td>A specialized search engine that searches web links that have been vetted by teachers and library media specialists. Of particular value is the advanced search feature that allows users to search for materials by grade level and select whether the information is supported with many or few pictures. A valuable tool for locating materials that are at the right cognitive level for students.</td>
</tr>
<tr>
<td>Google</td>
<td>Before initiating your search, click on the advanced search link to the right of the search box. Then, notice the option for reviewing the research results by readability in the middle of the screen. Select an option to receive readability information about your search results.</td>
</tr>
</tbody>
</table>

The training problem was analyzed, and it was determined that skill deficiencies could be ameliorated through design. That is, task analysis of the goal of producing accessible tiered webpages illustrated the task could be broken into a series of steps that could be completed one by one and that several of these steps could be handled automatically by a computer program. As a result, users could simply select items from a menu or enter information into a text box and the program would build webpages from that information. What was initially thought to be a large problem of creativity was actually a structured procedural task. The open-source programming language, Python, was used to turn the process of generating accessible tiered webpages into a web-based tool, Jen: The Tiered Web Page Generator (http://www.tieredwebpages.com).

The workflow was organized in a five-step sequential process. First, users set up the overall lesson properties. Next, they configure the tiers. Third, they enter the content for each tier in each subsection. Fourth, they are given the option of adding images, an optional step in the process. Finally, users can preview their lesson, make edits, and download the resulting files. As users complete each step, the content is saved to an online database, allowing users to take breaks and resume lesson creation across multiple sessions.

Product development began with the construction of a supporting database. This was necessary to deal with the issues of storing content entered by users, maintaining metadata about the lessons, managing user accounts, and more. Building on the database, an interface was created for each step of the webpage creation process (see Figure 1). The product became functional when the implementation of the automatic processing that turns information stored in the database into a collection of interlinked webpages using an accessible HTML template was completed.

The HTML template used at the earlier workshops was improved and adapted for automatic processing. Embedded in the template are vozMe and Google Translate APIs for on-demand text to speech and language translation. The template...
also includes a small option bar that allows students to easily adjust font size and color scheme. When URLs are included in the content, they are automatically turned into clickable links.

Since its initial launch, Jen has been upgraded to calculate some basic text statistics such as Automated Readability Index (http://en.wikipedia.org/wiki/Automated_Readability_Index) to assist in creating tiers with sufficient differentiation. An optional step allows users to add up to three images to illustrate the text found on each page. A design decision was made to feature all images on the content page of all tiers. Figure 2 illustrates a sample page generated by Jen.

On completion of the lesson or unit development, Jen generates a series of files that are downloaded to the user’s desktop in a compressed format (.zip). After the files are extracted and uncompressed, they can be installed on a web server or an individual computer or used on a USB drive. The webpages, created in HTML and CSS, are viewable by any web browser on any computer. An Internet connection is required to use the text-to-speech and translation functions.

Lessons Learned

To date, Jen has been used in 10 workshops in the Midwest. The results have been encouraging, as 90% of the teachers leave with a tiered web-based unit they can use in their classroom (some participants are not classroom teachers and therefore have no next-day application for the digital lesson they created). Teachers are excited at what they can produce without knowing the details of HTML programming. Moreover, they are extremely excited to create something they can use in their classroom. They appreciate how this new tool demonstrates their commitment to diverse learners and are eager to return to the classroom to use the digital materials with their students.

Conclusion

Although inclusion has provided access to the general education classroom for students with disabilities, there are significant questions about whether they have gained full access to the curriculum. In many classrooms, students routinely encounter required textbooks with a readability level far beyond their independent reading level (Allington, 2002; Cibrowsi, 1993). Since few alternative formats are provided, there is little evidence that the curriculum is accessible for students whose disabilities and reading skills are below grade level.

The process of designing supports that can be embedded into the curriculum (Ketterlin-Geller & Tindal, 2007) has challenged us to think deeply about the instructional needs of diverse students to proactively value differences. This process has illustrated how anticipating differences can reduce or eliminate the need for accommodations and modifications. Rather than thinking about disability as a wholly different type of learner, we have begun to conceptualize disability as a continuum for the purposes of instructional design. That is, some learners have little knowledge and skill and therefore interact with content and perform as a novice. At the other end of the continuum, some learners have considerable expertise and therefore need pathways that reinforce what they know while leading them to advance stages of understanding.

The hope is that this work will inspire other educators and developers to use their insight and knowledge about special needs to create new products and strategies to help struggling students gain meaningful access to the curriculum. The next phase of work will seek to collect large-scale evidence about the value of the webpages being created through the tiered webpage generator.

Declaration of Conflicting Interests

The authors are co-developers of Jen: The Tiered Web Page Generator.

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References


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