SOFTWARE AND RESOURCE CONSIDERATIONS FOR
TEACHING ONLINE/HYBRID COURSES

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Teaching online or hybrid courses necessitates more than a learning management system (LMS), a textbook, and an online homework system. The platforms one employs for distribution of course information and materials, course readings (including online textbooks and online readings), and any online homework system must be device-independent and have no limitations for the devices which course members may use, such as iOS, Windows, or Chrome devices, tablets, or smartphones. Accessible design standards should be met so that all course information, materials, and resources – both optional and required – can be used by all members of the class: these include but are not limited to use of alternate text for images, course documents which support the use of screen readers and allow the user to enlarge (zoom-in on) text and images, and captions or a transcript for videos. Course content must be manageable, reliable methods for communication must be employed, and consistent and regular interact must be incorporated throughout the course among students as well as between the instructor and the students. Finally, evaluation methods should be comprehensible for students as well as practical for use, and course activities – readings, assignments and/or projects, group activities, and assessments – must be doable for all class members, including those studying afar and those with special needs such as learning or physical disabilities. The focus, as with any course, should be on learning with special attention to employing technologies in ways that foster inclusion of and interaction among all course members.

My perspective regarding teaching online and hybrid courses was gained through teaching twenty-two (22) sections of an online/hybrid introductory statistics course, the first of which I taught during summer 2005. Teaching these online/hybrid course sections as well as employing various online resources, many of which I created, in my face-to-face courses, has provided opportunities to deal with problems which arise with different versions of Blackboard (the LMS used at Framingham State University), online homework systems such as MyMathLab/MyStatLab and WileyPLUS, and students' use of their devices – laptops, tablets, and smartphones. In addition, teaching online and using virtual resources provided openings to work with students who have little or no experience with online learning, limited understanding of the use of virtual learning environments, and surface knowledge of the capabilities of the various devices they own and use. These experiences provided valuable occasions to make connections with students as well as opportunities to continue to gain knowledge of the ever-changing virtual environments employed in online education and the software and hardware we use.

When teaching online, it is important to be flexible regarding the virtual tools employed. Colleges and universities update and change learning management systems as well as add new components. Online homework systems available with textbooks and publisher-independent systems are revised and new systems are developed. Such changes are important as software/apps and hardware – laptops, tablets, and phones – continue to evolve and provide new capabilities which can be employed in virtual learning. However, continual changes in software/apps and hardware leads to a game of catch-up for virtual environments so that some work better with these new technologies than others; this leads to instructors dealing with the access problems and errors encountered by students.

Students studying in virtual environments are not on equal footing in regard to the software/apps and hardware that they use. While many students own a laptop, some do not: there are still students who use computers available at their place of work or on campus. These computers range in age, processor type and speed, RAM, and available storage. For example, it is important to keep in mind that Chromebooks cannot run standard Windows applications and, for the most part, are dependent on cloud-based apps and services; there are providers which allow remote access to some Windows or Mac applications. Similarly, iOS apps do not function in a Windows environment and vice versa. Mac versions and Windows versions of applications are not identical: an example of this is that Active-X controls in an MS Excel workbook or an MS Word document created using a Window machine do not function on a Mac. In addition, resources created using an older version of an application may appear differently when viewed using newer versions of the same software or not open at all; resources created using new versions of applications may not function on machines using older version of the same software. Although documents created using applications such as Pages for Mac or Corel WordPerfect can be exported for MS Word, there can be availability issues for some aspects including fonts and compatibility issues for spacing, tables, or some formats. Software and hardware availability and differences can affect students work on projects as well as file sharing for group work. Those with limited access to computers may be further impacted due to their dependence on tablets or smartphones for daily course work or their lack or inadequate of internet access at home.
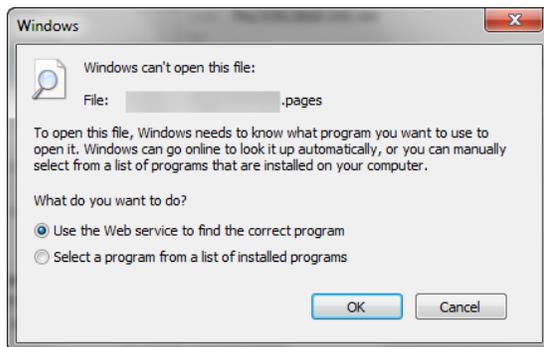

**Figure 1**: Windows does not recognize a file created using Pages on iPad.
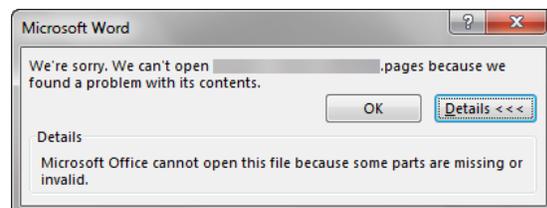
Figure 2: Selecting MS Word 2013 to open a pages file results in an error message.

Course content should be convenient and accessible via the various devices to which

students have access – Windows or Mac computers, Chromebooks, tablets, and smartphones. It is important for instructors to consider the varied devices that students may use to access course content rather than selecting applications based on their personal familiarity or access. For example, a file created using Pages is unrecognizable on a Windows computer (Figure 1). Selecting MS Word to open a Pages file produces error messages (Figure 2 and Figure 3) as an iOS Pages file is not compatible with MS Word.
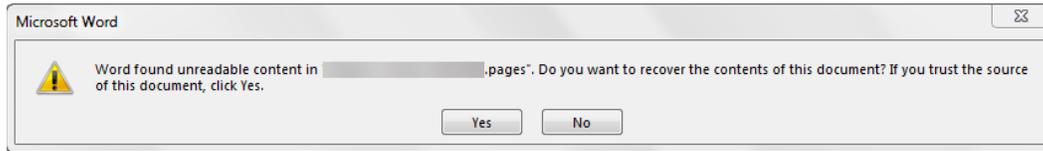
Figure 3: Selecting MS Word 2013 to open a pages file results in an error message.
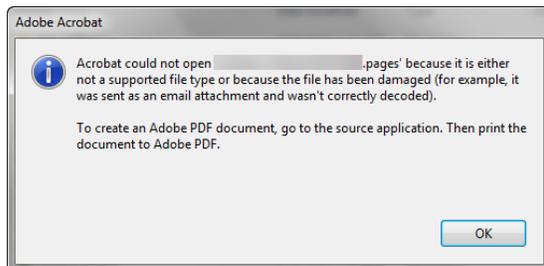

Figure 4: Selecting Adobe Acrobat to open a pages file results in an error message.
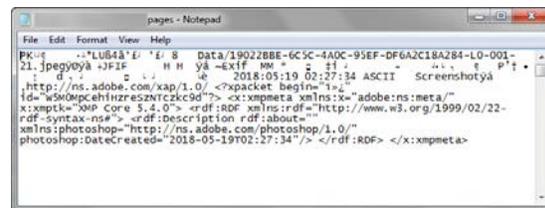

Figure 5: Selecting MS Notepad produces gobbledygook.

Selecting Adobe Acrobat (Figure 4) or MS Notepad (Figure 5) as the application with which to open a Pages file results in an error message and a file containing gobbledygook, respectively; attempting to open a Pages file using MS WordPad produces a file containing gobbledygook as well. Using MS Word is not an acceptable alternative as a MS Word file containing tables (or tables within tables to create a fill-in form) may not display appropriately when opened with Pages on an iPad or an iPhone. I mention these applications as they are popular choices for Windows and Mac users; similar compatibility issues exist between MS PowerPoint and Keynote as well as between MS Excel and Numbers.

An additional problem with applications such as MS Word or Pages for creating and viewing course documents and resources is the user's ability to alter the content in these files: course materials should be static so that content is unchangeable and can be viewed in the same form and manner by each student. While one may consider using Google Docs as a solution to the compatibility problem since documents are accessible online to those with whom they are shared or those to whom a link is provided (Figure 6) and may be set so that documents may be viewed but not edited (Figure 7) online, users are not prevented from downloading files in editable formats (MS Word, OpenDocument, Rich Text, or Plain Text formats – not all of which support images, tables, and formatting used to present information). Changing sharing settings (Figure 8) for Google Docs files to disable file download limits students to using resources online and is problematic for those who have inadequate internet access at home; this option disables printing and copying options as well.
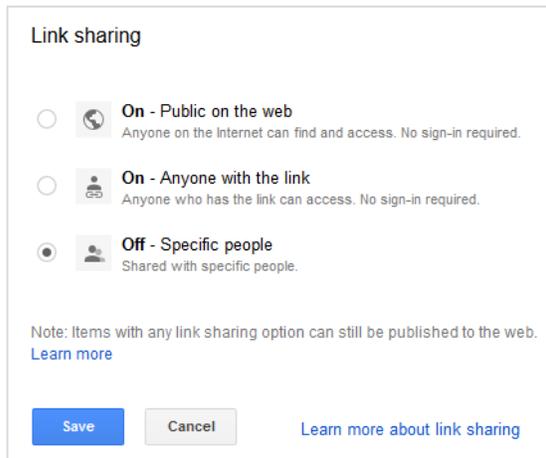
Figure 6: Link sharing options for Google Docs.
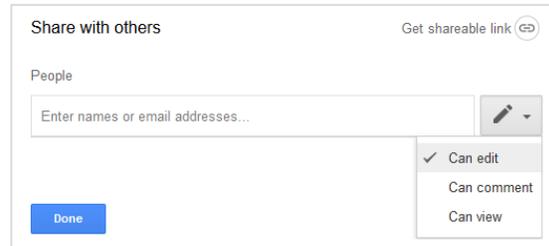
Figure 7: File sharing options for Google Docs.
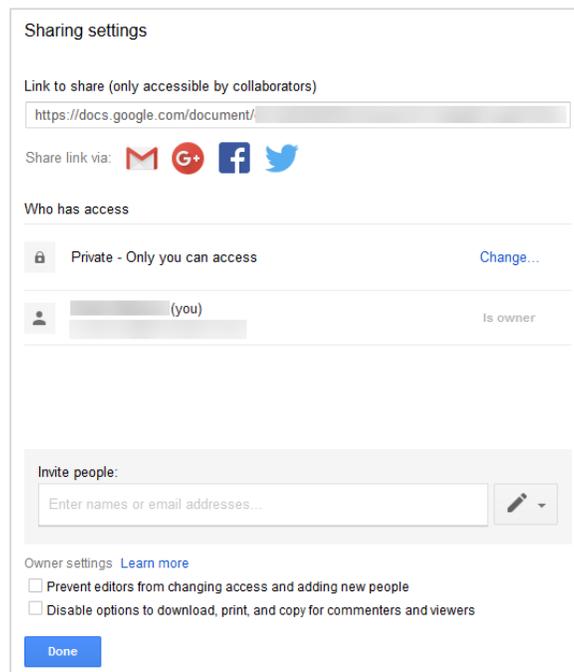
Figure 8: Sharing settings for Google Docs.

All files should be ADA accessible. While one may enlarge text using a virtual magnifying glass app on a computer or a magnifier app on a mobile device, doing so is cumbersome. Files should support zoom features as well as screen readers while maintaining formatting so that information is conveyed to all students in the same form. Files saved in portable document format (PDF), an open standard maintained by the International Organization for Standardization (ISO), is independent of application, hardware, and operating system. PDFs can contain, among other things, hyperlinks, form fields, audio, and video, support zoom and search in virtual environments as well as on devices, and support the use of screen readers. In addition, documents created using, for example, MS Office, Pages, Keynote, and Numbers for both Mac and iOS, Google Docs, WordPerfect, and OpenOffice

can be saved to PDF. Course documents saved to PDF have the same appearance and can be used in the same manner online as well as when saved to devices, and these documents do not allow accidental editing which can occur with files created using applications such as MS Office files, Pages, Keynote, and Numbers for Mac or iOS, Google Docs, WordPerfect and OpenOffice. MS Office files, as well as those from other applications, saved to PDF can be created with document structure tags for accessibility; when saving to PDF, for MS Office files, select this preference (Figure 9) using the Options button in the Save As dialog box. In addition, Adobe Acrobat Pro can be used to check accessibility of PDF files created using other applications as well as make PDF files accessible using the Action Wizard. PDF files are transferable and, with appropriate applications, can be edited and marked-up for group work; Adobe Reader and other free applications like iBooks and Kindle support dictionaries, bookmarks, comments and notes, and mark-up of PDF documents.
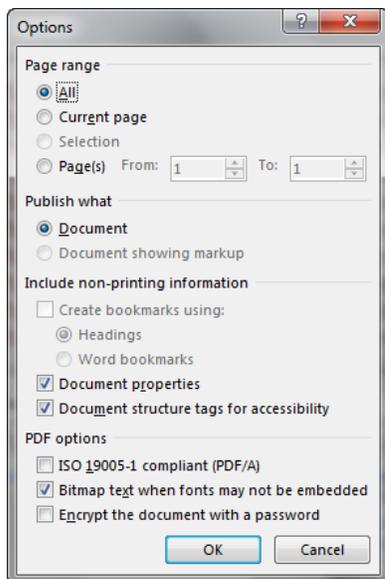

Figure 9: Options for PDF files created using MS Office.
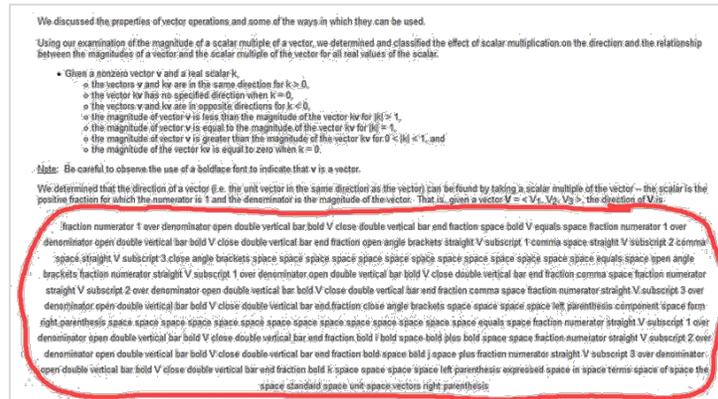

Figure 10: Gobbledygook created by Blackboard's equation editor.

While MS Office, for example, provides an equation editor and symbols, Design Science's MathType provides greater functionality as well as accessibility options. MathType works with applications such as MS Office, Pages, Numbers, and Keynote for Mac, Corel Office, OpenOffice for Windows and Mac, and Google Drive applications, learning management systems such as Blackboard, Desire2Learn, and Moodle, and email clients such as Apple Mail, MS Outlook, Outlook.com, GMail, and Yahoo Mail; at the writing of this paper, MathType does not yet work with Office 365/2016 for Mac. I have found MathType particularly helpful when Blackboard's equation editor renders expressions/equations improperly (Figure 10); to date, the University's Educational Technology Office has not responded to my inquiry about Blackboard's rendering of expressions/equations in this manner. In addition to its interactive equation editor functions which are, of course, useful for handouts, quizzes, and examinations, using the handwriting recognition utility built into Windows 7 or later, handwritten equations/expressions can be entered into MathType and

edited. Other benefits of MathType its working with MathML (Mathematical Markup Language) to produce math on the web, the MathPlayer[1], Design Science's free universal math reader which enables mathematics to be spoken in assistive technology products, and MathDaisy, Design Science's application which enables MS Word documents containing mathematical expressions and equations to be saved as a DAISY (Digital Accessible Information SYstem)[2] electronic book which can be read by students with vision or learning disabilities using MathPlayer-enabled DAISY player applications on a computer or enabled eBook reader; that is, MathType makes mathematics accessible to students with disabilities[3].

One of my favorite applications is TechSmith's Snagit. This application can be used for screen captures, image creation, editing, and mark-up, and video creation. I regularly use Snagit to share information with students via email for class and advising, in discussion forums, and during online sessions using Blackboard Collaborate (Ultra). Snagit's screen capture capabilities are particularly useful for creating images for directions and handouts for using resources or learning applications, image captures for publications such as this, and image-capture and printing of pages with formatting which make printing difficult. I used Snagit to create, edit, and mark-up the images in the figures in this paper as well as those for the mini-course and workshop handouts posted on my website. Images created using other applications as well as pictures or screen captures created using tablets or smartphones can be imported, edited, and marked-up. The mark-up features are useful for grading and providing feedback for written work submitted via email or LMS as well. Screen captures can be saved as various image types as well as to PDF and imported into other applications.

My other favorite TechSmith application, Camtasia, has enabled me to create videos for use in my classes. Camtasia is a user-friendly, powerful application with which one can create screen recordings with voice narration as well as edit videos. I have used Camtasia to create Blackboard and website tours, videos using MS PowerPoint, and videos with live-action captures worked examples, derivations, and proofs using my tablet PC, all of which have voice narration. Both the image and sound can be edited using Camtasia and media created using other applications can be imported in to Camtasia projects. Webcam video can be recorded during screen recordings, and the webcam video can be used with various effects such as mouse movements, keystroke notations, images, and annotations to create useful course tools. In addition, hotspots can be included for branching to locations within a video for review or as-needed learning or for hyperlinks to external sites as well as quiz elements with or without feedback for assessment to create interactive videos and SCORM content packages which can be used with a SCORM-compliant LMS. Camtasia videos which can include visual and audio effects, green screen, and captions can be produced as stand-alone videos which can be posted on a website, as well as shared to Vimeo, YouTube, Google Drive, and Screencast.com; screencast.com is TechSmith's hosting service which allows for image and video sharing as well as provides reports for hosted videos containing

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[1] Design Science MathPlayer, http://www.dessci.com/en/products/mathplayer/
[2] DAISY Consortium, http://www.daisy.org/about-us
[3] Design Science MathDaisy, http://www.dessci.com/en/products/mathdaisy/

quizzing. An important considerations for me when creating videos include accessibility of content, format, application, and device independence, designing videos to meet the needs of the students, and including the work and explanation so that students are involved in learning content; my desire, especially for online/hybrid courses, is for videos to mimic the face-to-face classroom environment so that "we" work together rather than to have videos be show-and-tell of formulas and results. Important parts of useful video creation include clear audio and video, captions and/or a full transcript, explanation of all terminology and notation, and, of course, proper presentation and discussion of the concepts and methods of mathematics/statistics. I have chosen to post my videos on YouTube (accessible by invitation only) and screencast.com (accessible by invitation or hyperlink access only) and my SCORM content packages on Blackboard. These options provide easy access to videos using the devices available to students – PC or Mac, tablet, and smartphone.

While I have explored whiteboard apps such as *Doceri*, *Educreations*, *ShowMe*, *Explain Everything*, *BaiBoard*, and *Whiteboard HD*, as well as use of social media, *FaceTime*, *Skype*, and text messaging for communication, I believe that inclusion is more important than convenience. Using email for communication as well as the various resources available through an LMS minimizes the *have* vs. *have-not* aspects of online education while making it possible for course members to join-in during all online meetings and sessions. To that end, I schedule regular online office hours and problem sessions via Blackboard Collaborate (Ultra) for my online/hybrid classes as well as maintain and monitor a daily open session for drop-in meetings among students as well as with me. I believe that these are important for developing a sense of community for online/hybrid courses.

Other resources worth mentioning include GeoGebra, and Paul Seeburger's *CalcPlot3D* for graphing (both of which can be used online via tablet and smartphone) and *Ted Talks* to provide students a purpose for learning as well as real world considerations and applications for the mathematics/statistics that they study. A hardware capability that
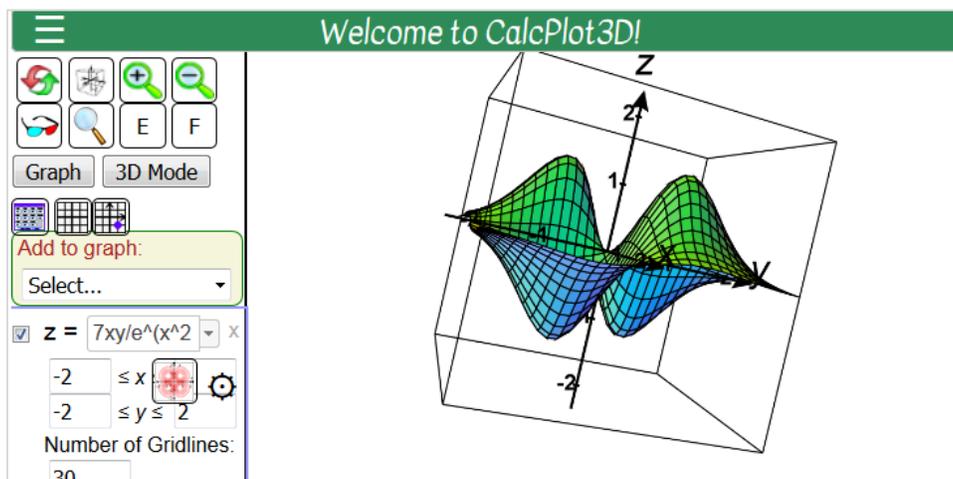
Figure 11: CalcPlot3D is an interactive online resource for visual exploration of mathematics.

students rarely consider is the ability to "scan" written work to PDF using a tablet or smartphone – for example, taking a picture using the camera on an iPad or iPhone and saving the image to PDF in iBooks. Other tablet and smartphone capabilities include mark-up of files in apps such as iBooks and Kindle and the ability to save files created using, for example, Pages for iOS as MS Word or PDF files.

There are many applications and resources which I have not mentioned that can be used to enhance the online/hybrid course experience. In this paper, I chose to discuss aspects of applications and hardware which I believe are most beneficial to students and instructors while discussing related aspects of accessible design. Overall, I believe that we must meet the needs of the students that we have while being flexible and creative, and we must keep in mind that learning mathematics/statistics involves *doing* mathematics/statistics.

Additional Resources – The resources to which hyperlinks are included below provide information about accessible design, creating web accessible resources, how screen readers function on accessible documents (video), a web tool for testing documents for accessible design, and how to create accessible PDF and MS Office documents.

- University of Washington's *What is the difference between accessible, usable, and universal design?* page, https://www.washington.edu/doit/what-difference-between-accessible-usable-and-universal-design

- Grand Valley State University Disability Support Resources' *Making Documents Accessible* page, https://www.gvsu.edu/dsr/making-documents-accessible-90.htm

- W3C Web Accessibility Initiative (WAI) *Making the Web Accessible* page, https://www.w3.org/WAI/

- W3C Web Accessibility Initiative (WAI) *Accessibility Principles* page, https://www.w3.org/WAI/fundamentals/accessibility-principles/

- W3C Web Accessibility Initiative (WAI) *Essential Components of Web Accessibility* page, https://www.w3.org/WAI/fundamentals/components/

- W3C Web Accessibility Initiative (WAI) *How to Meet WCAG 2 (Quick Reference)* page, https://www.w3.org/WAI/WCAG20/quickref/

- WebAIM (Web Accessibility in Mind) *WAVE Web Accessibility Evaluation Tool*, https://wave.webaim.org/

- Adobe *Opening and Reading PDF Documents with Accessibility Tools* video, http://tv.adobe.com/watch/accessibility-adobe/opening-and-reading-pdf-

documents-with-accessibility-tools/

- WebAIM (Web Accessibility in Mind) *PDF Accessibility* page,
  https://webaim.org/techniques/acrobat/acrobat

- The National Cener on disability and Access Education (NCDAE) *Creating Accessible PDF Documents In Adobe Acrobat XI* page,
  http://ncdae.org/resources/cheatsheets/acrobat-xi.php

- Adobe *Accessibility Resources* page,
  https://www.adobe.com/accessibility/resources.html

- Adobe *Create and Verify PDF Accessibility* (Acrobat Pro) page,
  https://helpx.adobe.com/acrobat/using/create-verify-pdf-accessibility.html

- WebAIM *PDF Accessibility* page (MS Office, OpenOffice, and Adobe Acrobat),
  https://webaim.org/techniques/acrobat/converting

- Microsoft *Create Accessible PDFs* page, https://support.office.com/en-us/article/create-accessible-pdfs-064625e0-56ea-4e16-ad71-3aa33bb4b7ed

- Santa Rosa Junior College *Creating Accessible PDF Documents* page (MS Word and Adobe Acrobat Pro Accessibility Wizard),
  https://de.santarosa.edu/accessibility/creating-accessible-pdf-documents

- Microsoft *Make Your Word documents Accessible* page (includes options for Windows, Mac, iOS, Android, Windows 10 app, and Online),
  https://support.office.com/en-us/article/make-your-word-documents-accessible-d9bf3683-87ac-47ea-b91a-78dcacb3c66d

- Microsoft *Make Your PowerPoint Presentations Accessible* page (includes options for Windows, Mac, iOS, Android, Windows 10 app, and Online),
  https://support.office.com/en-us/article/make-your-powerpoint-presentations-accessible-6f7772b2-2f33-4bd2-8ca7-dae3b2b3ef25

- Microsoft *Make Your Excel Spreadsheets Accessible* page (includes options for Windows, Mac, iOS, Android, Windows 10 app, and Online),
  https://support.office.com/en-us/article/make-your-excel-spreadsheets-accessible-6cc05fc5-1314-48b5-8eb3-683e49b3e593

- Michigan State University *Creating Accessible Pages Documents* page,
  https://webaccess.msu.edu/Tutorials/pages.html

- Pennsylvania State University *Tagged PDF on a Mac* page (options for Office

2016, Office 365, and OpenOffice),
http://accessibility.psu.edu/microsoftoffice/microsoftofficepdfmac/

- Design Science MathType,
  http://www.dessci.com/en/products/mathtype/default.htm

- Design Science MathPlayer,
  http://www.dessci.com/en/products/mathplayer/default.htm

- Design Science MathDaisy,
  http://www.dessci.com/en/products/mathdaisy/default.htm

- DAISY (Digital Accessible Information SYstem) Consortium,
  http://www.daisy.org/

- TechSmith Snagit, https://www.techsmith.com/screen-capture.html

- TechSmith Camtasia, https://www.techsmith.com/video-editor.html

- CalcPlot3D,
  https://www.monroecc.edu/faculty/paulseeburger/calcnsf/CalcPlot3D/

- GeoGebra, https://www.geogebra.org/

- TED, https://www.ted.com/