MICROSOFT WINDOWS 8.1 NOTEBOOK VS. CHROMEBOOKS FOR EDUCATION

Give students the functionality of a Windows® notebook running Microsoft® Office

Meets or beats the price of a Chromebook™

up to **67**% **time saved** for online & offline classroom tasks

ability to save docs in any format every time	seamless compatibility online and offline	more features available than Google Docs™	access to thesaurus and spellcheck any time	faster opening of blank documents

*Windows HP Stream 11 notebook versus Acer® C720P-2600 and C720P-2457 Touchscreen Chromebooks

Many budget-conscious school systems are considering Chromebook purchases, believing that their affordability offsets their many disadvantages. Now, these same budget-conscious schools have the ability to purchase powerful Windows notebooks running Microsoft Office for a price equal to or lower than that of a Chromebook.

In the Principled Technologies labs, we tested an HP Stream 11 notebook running Windows 8.1 and Microsoft Office and two configurations of the Acer C720P Touchscreen Chromebook running Google Docs on Chrome OS™ 42. We conducted a series of online and offline scenarios resembling students' daily activities, measuring the time to complete tasks and evaluating the user experience with the two different sets of tools. We found the Windows notebook completed all of the tasks faster—with time-savings of up to 67 percent—and delivered a more robust and fully functional experience both online and offline.

THE LIMITATIONS OF CHROMEBOOKS

Chromebooks attract some schools and school systems because of their low purchase price. Unlike Windows-based notebooks that run software applications from their hard drives and save files to these same hard drives, Chromebooks follow the cloud-computing model, where applications and users' files are no longer stored "locally" on their computers, but are now "out there" in the cloud and accessed through the web. Because the applications are often available for little to no additional charge, they appear to offer savings on software. However, as a 2013 Principled Technologies study found, the enormous bandwidth requirements of these devices can offset or even negate the savings. In addition, even when bandwidth is available, accessing applications and files over the Internet can take longer on Chromebooks.[1]

Another disadvantage of Chromebooks is the Google productivity suite of applications, commonly referred to as Google Docs.[2] This suite of apps does not offer complete functionality when the system is offline, making many features unavailable without an Internet connection.

Many of today's students have Internet access at home and school, places where they spend much of their time. However, today's students also spend an extensive amount of time on the go—at doctors' offices, sports practices, music lessons, and other places lacking Internet access. How helpful would it be if they could get their schoolwork done during these times?

THE VERSATILITY AND SPEED OF A WINDOWS NOTEBOOK AT THE PRICE OF A CHROMEBOOK

The HP Stream 11 is a Windows notebook with a price tag similar to many Chromebooks in the classroom; in fact, it is less expensive than both the Acer C720P Chromebooks we tested (see Appendix A for pricing). The HP Stream 11 can store applications and files locally and uses the Microsoft Office suite of productivity applications.

To learn how the HP Stream 11 with Microsoft Office compares to two configurations of the Acer C720P Chromebook with Google Docs when completing typical student tasks, we created a set of eight scenarios. Half of these represent online tasks and require an Internet connection; the other

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[1] Chromebook vs. Windows notebook network traffic analysis
www.principledtechnologies.com/Microsoft/Chromebook_PC_network_traffic_0613.pdf
[2] In our testing, we used the tier of Google services that is freely available to all; while this includes Google Docs, Google Sheets, and Google Slides, most people refer to the whole suite as Google Docs. Google also provides a separate suite called Google Apps for Education, which is available, free of charge, to those in registered schools.

scenarios represent students working offline. We created these scenarios to be as consistent and similar as possible on these devices despite using different software.

We executed all of the scenarios three times on each of the three test devices and report the median run. We also looked at the functionality that the applications delivered when we were offline.[3] Please note that our findings reflect functionality from both Google Chrome OS 42 and Microsoft Windows 8.1 as of June 2015 and may not represent functionality currently available because both Google and Microsoft are adding capabilities all the time.

Figure 1 summarizes our findings related to the time to perform tasks. Across the board, in both online and offline test scenarios, the HP Stream 11 Windows notebook needed less time than the Chromebooks.
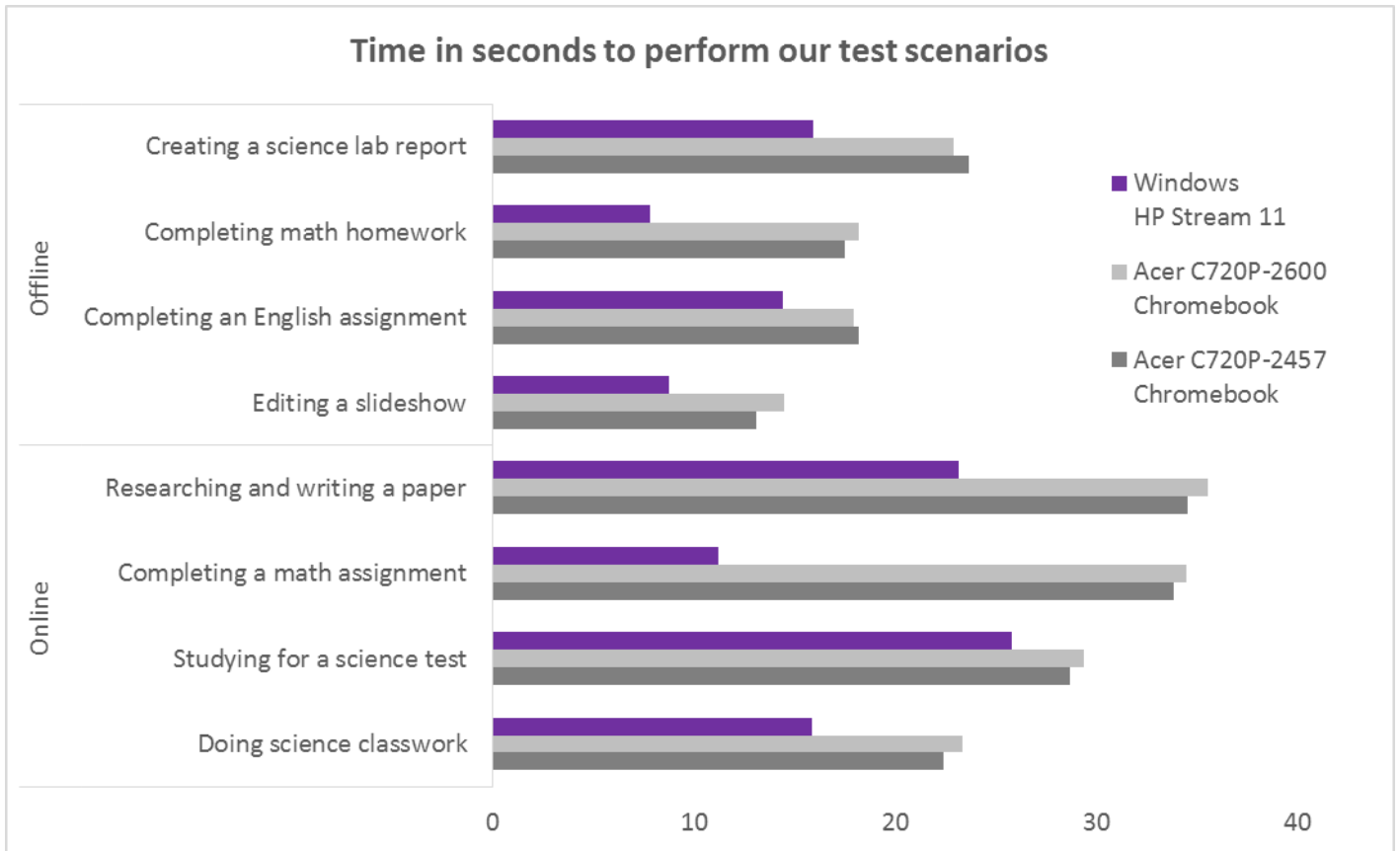
Figure 1: The HP Stream 11 Windows notebook took less time to perform every scenario than either Chromebook. Lower numbers are better.

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[3] Appendix A provides detailed configuration information and pricing for the test systems, Appendix B provides our test methodology, and Appendix C shows detailed results.

Microsoft Windows 8.1 notebook vs. Chromebooks for education

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Figure 2 presents a high-level summary of the reduced functionality of the Google Docs on the Chromebooks in offline mode compared to the Microsoft Office applications on the Windows notebook.

Google Docs on Acer Chromebooks	Microsoft Office apps on HP Stream 11
No templates available	Many templates available
Cannot access revision history	Use track changes and review/collaboration tools
Cannot save in non-native formats	Save in any format
Document conversion and import feature unavailable	Convert and open documents
Cannot copy, discard, move, and rename documents	Copy, discard, move, and rename documents
Cannot use spellcheck, thesaurus, or personal dictionary	Utilize spellcheck, thesaurus, personal dictionary
No help documentation available	Basic help documentation available
Formatting issues when opening docs in Google Docs	Correct formatting when opening documents in Office
Only basic editing available in Office compatibility mode	All online features available while editting .docx & .xlsx files
Cannot choose auto-substitutions and auto-formatting	Choose substitution and auto-formatting preferences
Insert chart only if you generate it before working online	Generate and insert charts
Cannot insert images in Google Sheets	Insert images in document
Cannot use print functionality in Google Slides or Google Sheets	Use print functionality

Figure 2: Summary of the feature differences we observed in offline mode.

Figures 3 through 6 illustrate the formatting issues we observed when opening docs in Google Docs on the Chromebooks. Figure 3 shows a correctly formatted section of a page of a Principled Technologies test report—with text, a chart, and a caption—as it appeared in Microsoft Word on the HP Stream 11. As Figure 4 shows, when we viewed this same section of the page in Google Docs on the Chromebook, the chart did not display.
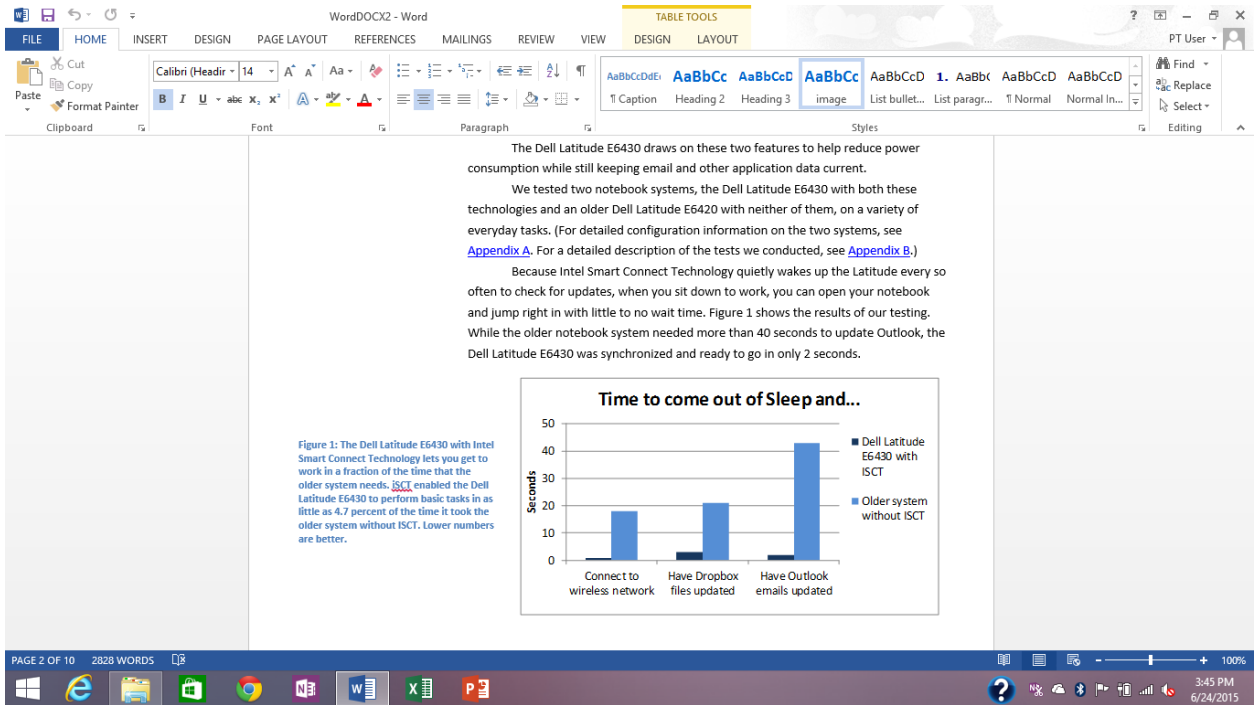
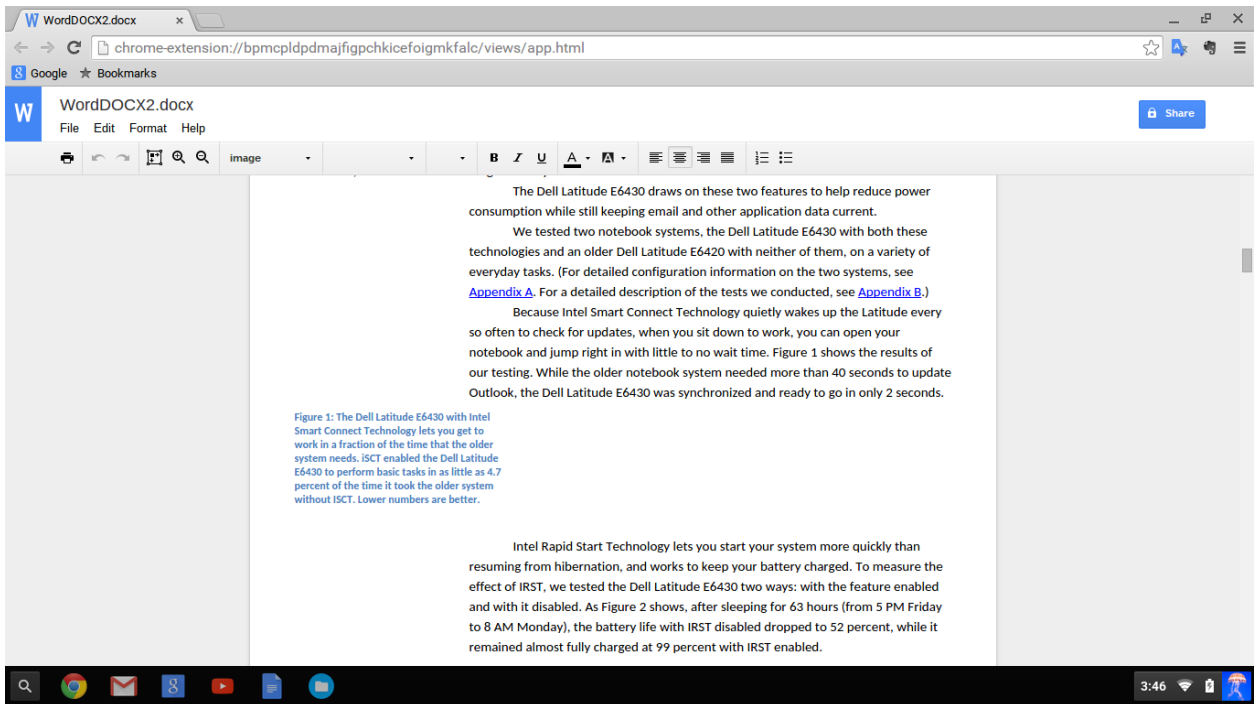**Figure 3: Portion of a document in Microsoft Word on the Windows notebook.**

Figure 4: The same portion of a document in Google Docs on the Chromebook.

Microsoft Windows 8.1 notebook vs. Chromebooks for education

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In addition to the limitations we observed when using Google Docs, we also experienced problems when using the Anatronica app offline on the Chromebook. As the screenshots below illustrate, this app was virtually unusable on the Chromebook when not connected to the Internet.
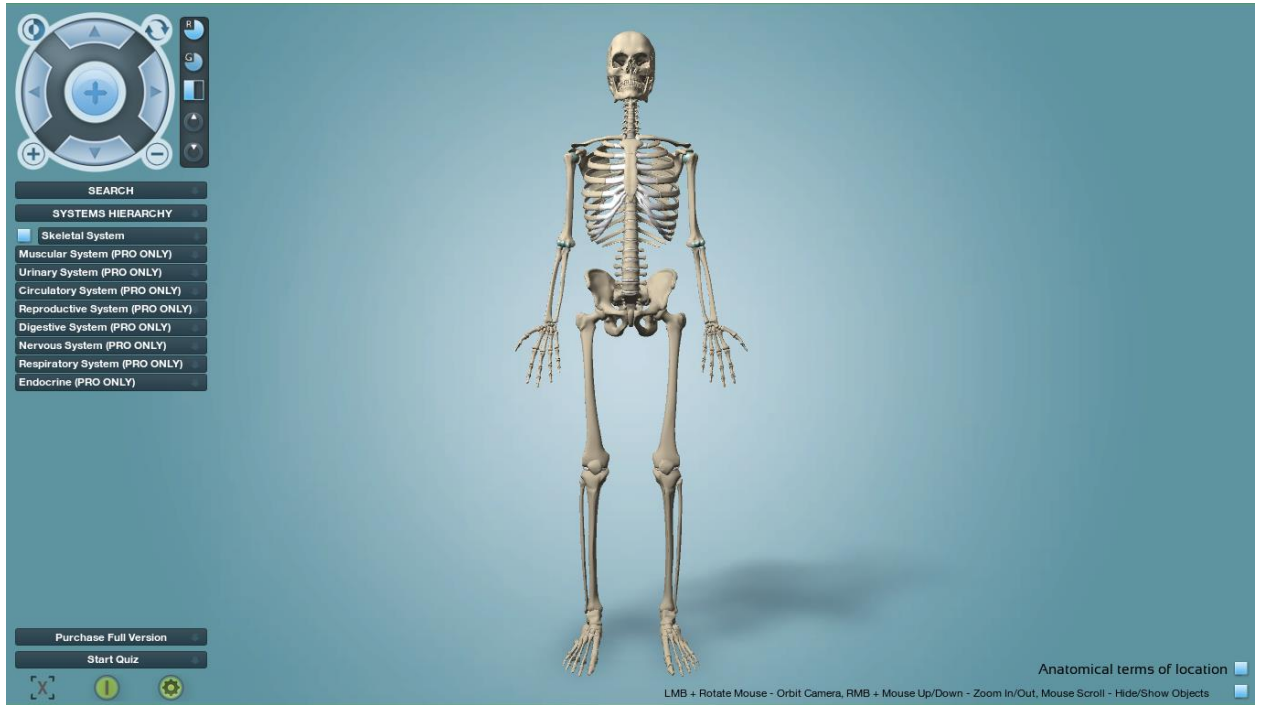

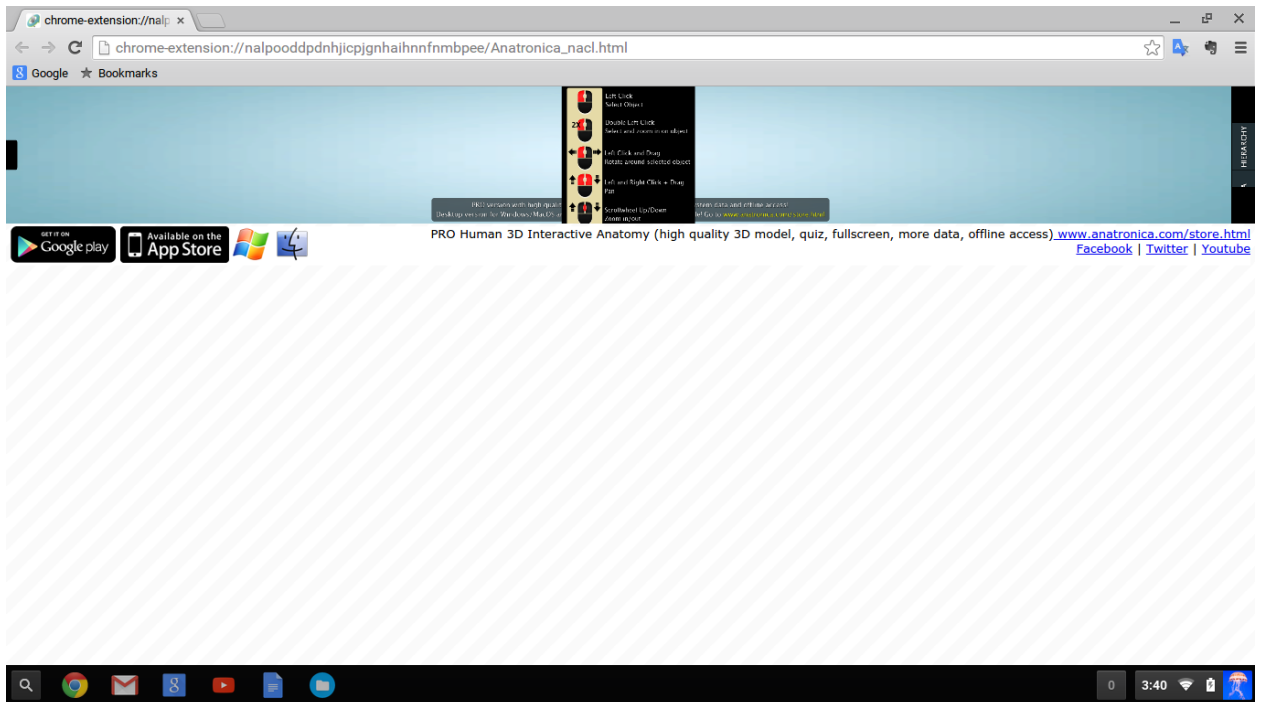**Figure 5: The Anatronica offline app on the Windows notebook.**

Figure 6: The Anatronica offline app on the Chromebook.

Microsoft Windows 8.1 notebook vs. Chromebooks for education

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OUR TESTING: ONLINE SCENARIOS

The following four scenarios all required online access for one or more apps or tasks.

Doing science classwork

In this scenario, we simulated a student doing some science classwork using Microsoft Office 2013 on the Windows notebook and Google Docs on the Chromebooks. The student first launched Microsoft Word or Google Docs and opened a new document for her assignment before opening the Biology textbook on Kno™ Textbooks for reference. After reading the necessary material, the student opened a 2.29MB PowerPoint® presentation from class to review the assignment details. After going through the presentation, the student launched the PhET Build an Atom website to work on her homework.

As Figure 7 shows, completing this scenario using Microsoft Office 2013 on the HP Stream 11 took 32.0 percent less time than doing so with the Google tools on the 2GB Chromebook and 29.2 percent less time than doing so with the Google tools on the 4GB Chromebook.

Figure 7: Time to perform our "Doing science classwork" scenario on the three devices we tested. Less time is better.

Studying for a science test

This scenario simulated a student studying for a science test. The student first launched Microsoft Word 2013 on the Windows notebook or Google Docs on the Chromebooks and opened a new blank document to take notes. Next, the student navigated to Khan Academy® and watched the "Anatomy of a Neuron" lesson. After the video was over, he navigated to the BioDigital Human website, where he studied the interactive 3D models showing the neurological effects of Alzheimer's disease and aphasia.

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As Figure 8 shows, completing this scenario using Microsoft Office 2013 on the HP Stream 11 took 12.2 percent less time than doing so with the Google tools on the 2GB Chromebook and 10.1 percent less time than doing so with the Google tools on the 4GB Chromebook.
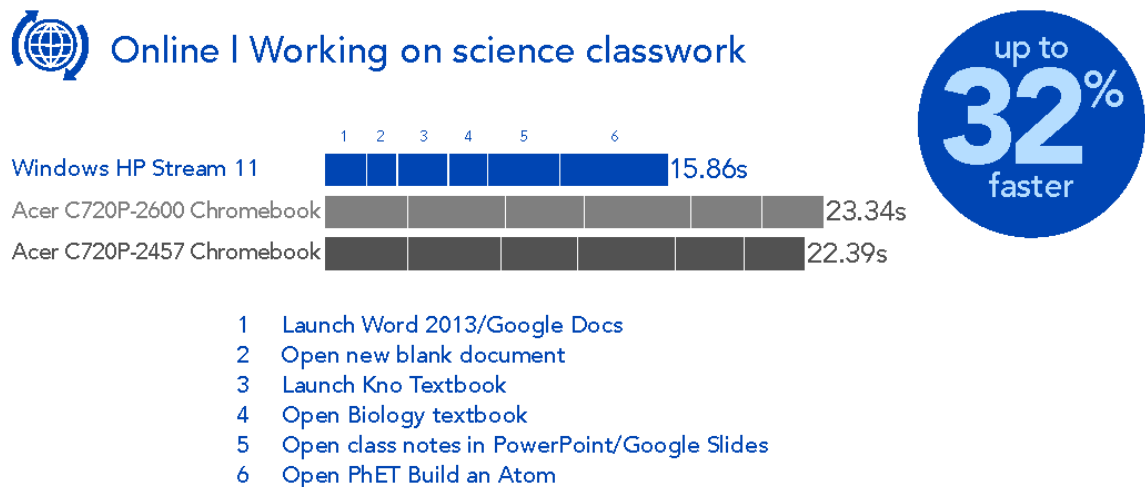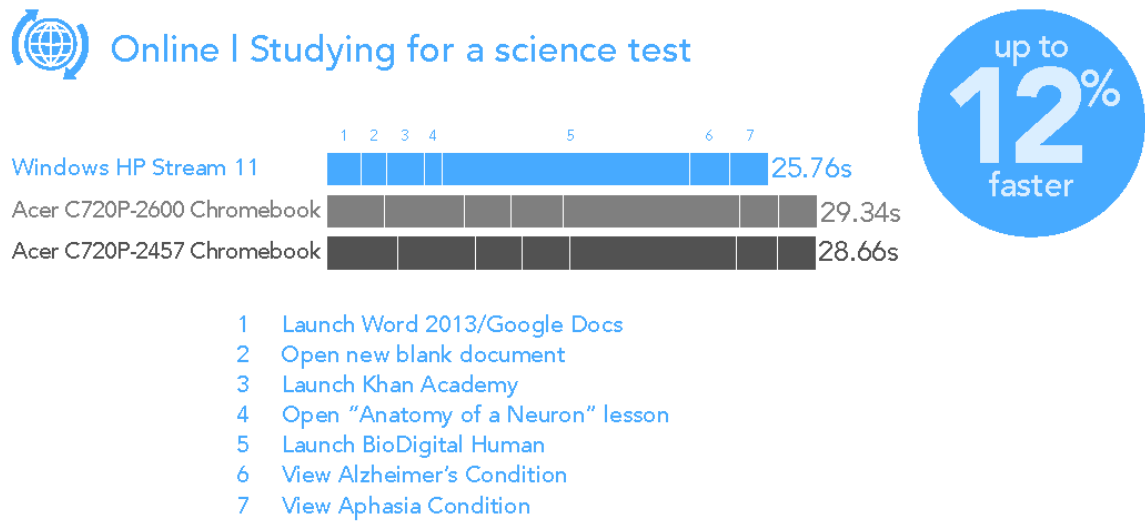

Figure 8: Time to perform our "Studying for a science test" scenario on the three devices we tested. Less time is better.

Completing a math assignment

In this scenario, we simulated a student completing a math assignment using Microsoft Office 2013 on the Windows notebook and Google Docs on the Chromebooks. The student first opened a 168KB spreadsheet of data. On the Chromebooks, the student had to save the Excel spreadsheet (XLSX file) as a Google Sheets file before she could edit it. The student then generated a line chart of their data in the spreadsheet before opening a new blank word-processing document for their assignment. Next, the student pasted the chart from the spreadsheet into the word-processing document and launched the GeoGebra® application to verify her results. Once the student felt satisfied with her work, she saved the document as a PDF to submit to her teacher.

As Figure 9 shows, completing this scenario using Microsoft Office 2013 on the HP Stream 11 took 67.5 percent less time than doing so with the Google tools on the 2GB Chromebook and 66.9 percent less time than doing so with the Google tools on the 4GB Chromebook.

Microsoft Windows 8.1 notebook vs. Chromebooks for education

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Online | Completing a math assignment

Windows HP Stream 11	11.19s
Acer C720P-2600 Chromebook	34.47s
Acer C720P-2457 Chromebook	33.85s

up to **67%** faster
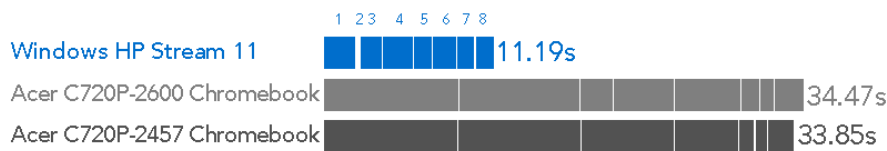
1 Open Excel file
2 Save Excel file as Google Sheets file (Chromebooks only)
3 Generate chart from datasheet
4 Launch Word 2013/Google Docs
5 Open new blank document
6 Copy and paste chart into document
7 Launch GeoGebra
8 Save document as PDF

Figure 9: Time to perform our "Completing a math assignment" scenario on the three devices we tested. Less time is better.

Researching and writing a paper

This scenario simulated a student researching, brainstorming, and writing a paper using Microsoft Office on the Windows notebook and Google Docs on the Chromebooks. The student first launched OneNote® (or Evernote® on the Chromebooks) to review his notes from class before opening a 2.29MB PowerPoint slideshow deck (PPTX file) of additional class notes for reference from his teacher. After looking through his notes, the student opened a new word-processing document for his paper and used Paint or CloudConvert to convert a 26.1MB PNG image into a smaller JPG for his cover page. The student then navigated to the MindMeister® web application and created a new Mind Map as a brainstorming tool. Once he finished writing his paper, the student launched Skype® on the Windows notebook or Google Hangouts™ on the Chromebooks so his fellow classmates could read his draft and give feedback.

As Figure 10 shows, completing this scenario using Microsoft Office 2013 on the HP Stream 11 took 34.8 percent less time than doing so with the Google tools on the 2GB Chromebook and 33.0 percent less time than doing so with the Google tools on the 4GB Chromebook.

Microsoft Windows 8.1 notebook vs. Chromebooks for education

A Principled Technologies test report **9**

Online I Researching and writing a paper

up to **34%** faster

Windows HP Stream 11	23.15s
Acer C720P-2600 Chromebook	35.52s
Acer C720P-2457 Chromebook	34.54s

1 Open OneNote/Evernote
2 Open class notes in PowerPoint/Google Slides
3 Launch Word 2013/Google Docs
4 Open new blank document
5 Launch Paint/CloudConvert
6 Convert 26.1MB PNG to JPG
7 Insert converted image into doc
8 Open Mindmeister
9 Create new blank Mind Map
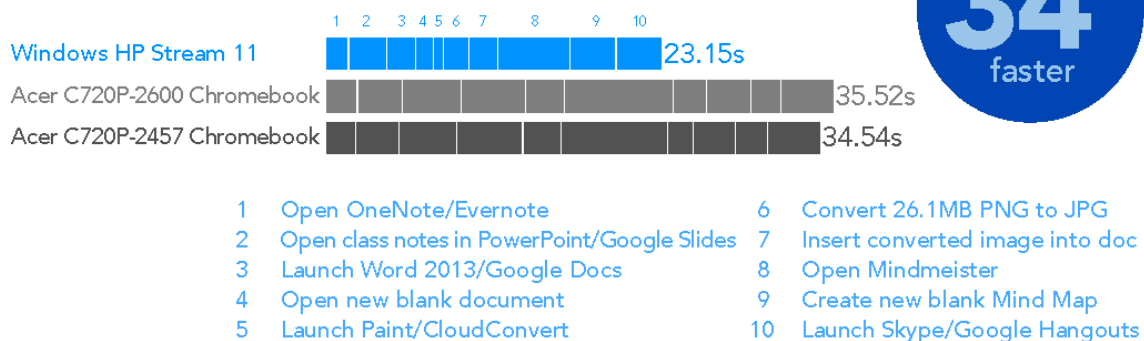10 Launch Skype/Google Hangouts

Figure 10: Time to perform our "Researching and writing a paper" scenario on the three devices we tested. Less time is better.

OUR TESTING: OFFLINE SCENARIOS

The following four scenarios did not require online access.

Editing a slideshow

This scenario simulated a student modifying a 2.29MB slideshow presentation by editing a 6.46MB JPG image file and inserting it into the slideshow. The student opened the slideshow in Microsoft Office PowerPoint 2013 on the Windows notebook or Google Slides on the Chromebooks. To edit the slideshow, the student used Microsoft Office PowerPoint 2013 on the Windows notebook or Google Slides on the Chromebooks. The student then opened an image in Microsoft Photo Gallery or the Google Drive™ photo viewer. Then, to perform a basic auto-adjust or auto-fix editing task before saving and inserting the image into the slideshow presentation, the student used Microsoft Photo Gallery on the Windows notebook or the built-in Google Drive photo-editing tool on the Chromebooks. Finally, the student inserted the image in the slideshow.

As Figure 11 shows, completing this scenario using Microsoft Office 2013 on the HP Stream 11 took 39.4 percent less time than doing so with the Google tools on the 2GB Chromebook and 32.9 percent less time than doing so with the Google tools on the 4GB Chromebook.

Microsoft Windows 8.1 notebook vs. Chromebooks for education

A Principled Technologies test report **10**

Offline | Editing a slideshow

up to **39%** faster

	1	2	3	4	
Windows HP Stream 11					8.79s
Acer C720P-2600 Chromebook					14.51s
Acer C720P-2457 Chromebook					13.10s

1 Open existing PowerPoint/Google Slides file
2 Open image in Photo Gallery/Google Drive
3 Auto-adjust/auto-fix image
4 Insert image into presentation

Figure 11: Time to perform our "Editing a slideshow" scenario on the three devices we tested. Less time is better.

As we tested, we discovered two additional issues with the Google Slides application. The PowerPoint slide decks we opened in Google Slides suffered from formatting issues and had limited theme options. We also found that to edit a PowerPoint presentation in Google Slides offline, we first had to convert to the Google Slides format in online mode.
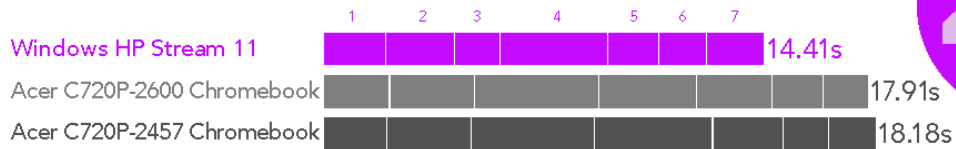
Completing an English assignment

This scenario simulated a student doing an English assignment using Microsoft Office 2013 on the Windows notebook and Google Docs on the Chromebooks. The student first opened her existing class notes in OneNote (Windows) or Evernote (Chromebooks), then launched Word 2013 or Google Docs and opened a new blank word-processing document to do her homework. After some time, she opened a 2.29MB PowerPoint presentation from her teacher of in-class notes. Once she finished her homework, she touched up a 6.46MB image in Microsoft Photo Gallery or Google Drive's built-in photo editor and inserted it into her homework document.

As Figure 12 shows, completing this scenario using Microsoft Office 2013 on the HP Stream 11 took 19.5 percent less time than doing so with the Google tools on the 2GB Chromebook and 20.7 percent less time than doing so with the Google tools on the 4GB Chromebook.

Microsoft Windows 8.1 notebook vs. Chromebooks for education

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Offline | Completing an English assignment

up to 20% faster

Windows HP Stream 11	14.41s
Acer C720P-2600 Chromebook	17.91s
Acer C720P-2457 Chromebook	18.18s

1 Open OneNote/Evernote
2 Launch Word 2013/Google Docs
3 Open new blank document
4 Open class notes PowerPoint/Google Slides file
5 Open image in Photo Gallery/Google Drive
6 Auto-adjust/auto-fix image
7 Insert image into document

Figure 12: Time to perform our "Completing an English assignment" scenario on the three devices we tested. Less time is better.
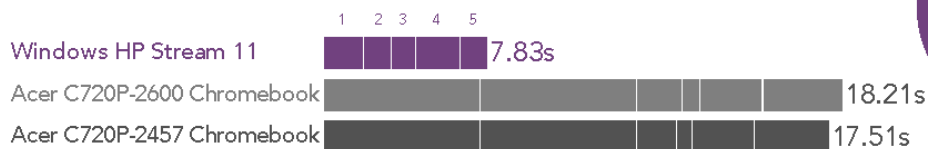
Completing math homework

In this scenario, we simulated a student doing math lab work with an existing spreadsheet. The student opened his 168KB spreadsheet in Microsoft Excel on the Windows notebook and Google Sheets on the Chromebooks. He generated a line chart from the data. The student then launched the GeoGebra app to double-check his results against the predicted results. Finally, he opened a new Microsoft Word or Google Docs file to write up his lab report.

As Figure 13 shows, completing this scenario using Microsoft Office 2013 on the HP Stream 11 took 57.0 percent less time than doing so with the Google tools on the 2GB Chromebook and 55.3 percent less time than doing so with the Google tools on the 4GB Chromebook.

Offline | Working on math homework

up to 57% faster

Windows HP Stream 11	7.83s
Acer C720P-2600 Chromebook	18.21s
Acer C720P-2457 Chromebook	17.51s

1 Open existing Excel/Google Sheets file
2 Generate chart from data
3 Launch GeoGebra
4 Launch Word 2013/Google Docs
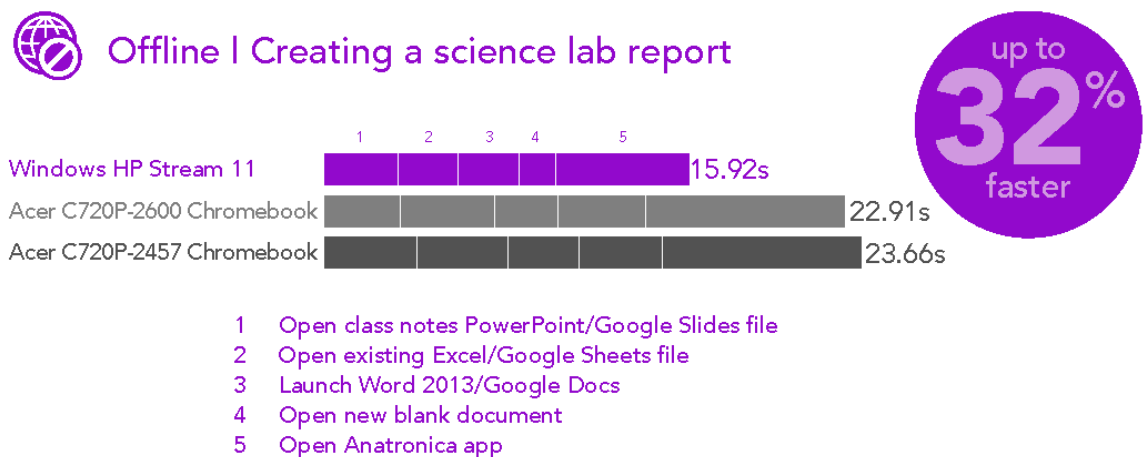5 Open new blank document

Figure 13: Time to perform our "Completing math homework" scenario on the three devices we tested. Less time is better.

As we tested, we discovered an additional issue with the Google Sheets application on the Chromebooks: We could not copy a chart from Google Sheets and paste into a Google Doc in offline mode. Using the Windows notebook, we easily copied charts from Microsoft Excel to Microsoft Word in offline mode.

Creating a science lab report

This scenario simulated a student creating a science lab report, using Microsoft Office on the Windows notebook and Google Docs on the Chromebooks. The student began by opening a 2.29MB presentation file from her teacher with class notes for reference and then opened a 168KB spreadsheet with lab results. After writing her lab report, the student launched the Anatronica app to fact-check her work against its skeletal system model.

As Figure 14 shows, completing this scenario using Microsoft Office 2013 on the HP Stream 11 took 30.5 percent less time than doing so with the Google tools on the 2GB Chromebook and 32.7 percent less time than doing so with the Google tools on the 4GB Chromebook.

Offline | Creating a science lab report

up to **32%** faster

	1	2	3	4	5	
Windows HP Stream 11						15.92s
Acer C720P-2600 Chromebook						22.91s
Acer C720P-2457 Chromebook						23.66s

1   Open class notes PowerPoint/Google Slides file
2   Open existing Excel/Google Sheets file
3   Launch Word 2013/Google Docs
4   Open new blank document
5   Open Anatronica app

Figure 14: Time to perform our "Creating a science lab report" scenario on the three devices we tested. Less time is better.

As previously illustrated, we discovered that the Anatronica offline app on the Chromebook had severe display issues that rendered it almost useless. We observed no such issues with the Windows version of Anatronica.

Microsoft Windows 8.1 notebook vs. Chromebooks for education

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COMPARING FEATURES AND FUNCTIONALITY

In the tables below, we present the differences in features and functionality an offline user would experience when working with the two productivity suites. Figure 15 compares differences in functionality that apply across all of the applications in the suites, and Figures 16 through 18 focus on specific applications.

Google productivity tools	Microsoft Office 365™
No document templates available offline.	Many document templates are available in offline mode with more available online.
No document templates available offline.	Many document templates are available in offline mode with more available online.
Document revision history not available offline.	Track changes and review/collaboration tools are available in offline mode.
Option to save to non-native formats (e.g., .pdf, .docx, .csv, .xlsx—anything other than .gdocs, .gsheets, or .gslides) unavailable in offline mode.	Option to save to any format available in offline mode.
Document import and conversion features unavailable in offline mode, severely limiting the ability to edit existing Office files (.docx, .xlsx, .pptx, etc.) in "Office compatibility mode."	Able to convert and open documents in both offline and online modes.
Document import and conversion features are unavailable in offline mode, severely limiting the ability to edit existing Office files (.docx, .xlsx, .pptx, etc.) in "Office compatibility mode."	Able to convert and open documents in both offline and online modes.
Unable to copy, discard, move, or rename documents when offline.	Able to copy, discard, move, and rename documents offline.
Spellcheck and personal dictionary not available offline. Note: Google Docs has no thesaurus.	Spellcheck, thesaurus, and personal dictionary are available in offline mode.

Figure 15: Overall differences in offline functionality with the two productivity suites.

Google Docs	Microsoft Word 2013
The .docx files we opened in Google Docs exhibited numerous formatting issues, missing images, etc.	The .docx files we opened in Word 2013 were formatted correctly.
When editing a. docx file in Office compatibility mode, only basic text editing and formatting are supported.	When editing a. docx file, all online features are available.
You cannot convert .docx files to .gdocs files in offline mode.	File import, export, and conversion all work in offline mode.
Unable to save/define default-formatting styles for headers, paragraphs, etc. in offline mode.	Able to save/define default-formatting styles for headers, paragraphs, etc. in offline mode.
Tools → Preferences for automatic substitution, lists, and smart quotes not available in offline mode.	Substitution and auto-formatting preferences fully available in offline mode.

Figure 16: Differences in offline functionality when using the two productivity suites for Word processing.

Microsoft Windows 8.1 notebook vs. Chromebooks for education

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Google Sheets	Microsoft Excel 2013
When editing an .xlsx file in Office compatibility mode, only very basic editing and formatting features are available.	All online features are available when editing an .xlsx file in offline mode.
Unable to convert .xlsx files to .gsheets format or import .csv files in offline mode.	File import, export, and conversion all work in offline mode.
When offline, you are able to insert a chart only if you have first generated the chart while online.	Ability to generate and insert charts in offline mode.
Existing charts are loaded in offline mode only if the document is loaded online first.	Being offline does not affect charts or the ability to manipulate them.
Unable to copy/paste charts in offline mode.	Able to copy/paste charts in offline mode.
Script gallery, script editor, and script manager are unavailable in offline mode.	Scripts and macros are available in offline mode.
Unable to insert images into document in offline mode.	You can insert images in offline mode.
Function list reference is unavailable in offline mode.	Function library and formulas are fully available in offline mode.
Spreadsheet settings (locale, time zone, recalculation preferences) not available in offline mode.	All document settings and preferences available to change in offline mode.
Print functionality is not available in offline mode.	Print functionality available in offline mode.

Figure 17: Differences in offline functionality when using the two productivity suites for working with spreadsheets.

Google Slides	Microsoft PowerPoint 2013
PowerPoint (PPTX) files opened in Google Slides often have compatibility issues in the form of missing or incorrect formatting, effects, etc.	PowerPoint files are formatted correctly.
Unable to convert PowerPoint (PPTX) files to the Google Slides format for full editing features in offline mode.	No limitations on editing or converting between presentation file types in offline mode.
Unable to load or change presentation themes in offline mode.	Able to load and change presentation themes in offline mode.
Unable to print or print preview presentations in offline mode.	Print functionality is unaffected by being offline.
Unable to import slides in offline mode.	Able to import slides from Slide Libraries or other presentations into current presentation in offline mode.
Unable to insert video or Word Art in offline mode.	All media and formatting types are available both online and offline modes

Figure 18: Differences in offline functionality when using the two productivity suites for working with presentations.

Microsoft Windows 8.1 notebook vs. Chromebooks for education

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CONCLUSION

If your school system is considering an investment in Chromebooks because of their attractive price point, you should look at the alternative—Windows notebooks such as the HP Stream 11. For the cost of a Chromebook or even less, your students can enjoy the complete functionality of Microsoft Office applications, with no need to worry about an Internet connection.

They can also spend less time waiting as they complete their work. In our tests, the HP Stream 11 Windows notebook completed a set of eight student scenarios—four of them online and four offline—up to 67 percent more quickly than the two Acer Chromebooks we tested.

For a school system with a limited budget, Windows notebooks such as the HP Stream 11 offer a cost-effective solution while providing ease of use and the complete functionality of Microsoft Office. Your students don't need to worry about access to the Internet to complete their work. They spend less time waiting and more time doing.

In our tests, we created eight student scenarios (online and offline) comparing the HP Stream 11 running Windows 8.1 to two Acer Chromebooks. Up to 67 percent of the tasks performed were completed faster using the HP Stream 11. With these type of results, it's easy to decide how to best meet the needs of your students. Get the power and flexibility of a Windows notebook for the price of a Chromebook.

Microsoft Windows 8.1 notebook vs. Chromebooks for education

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APPENDIX A – DETAILED SYSTEM INFORMATION AND PRICING

Figure 19 presents detailed information on the three systems we tested.

	HP Stream 11-d010nr	Acer C720P-2600 Chromebook 2 GB	Acer C720P-2457 Chromebook 4 GB
Configuration			
Processor	Intel Celeron® N2840	Intel Celeron 2957U	Intel Celeron 2957U
Processor frequency (GHz)	2.16	1.4	1.4
Processor cores	2	2	2
Memory	4GB DDR3L SDRAM	2GB DDR3L SDRAM	4GB DDR3L SDRAM
Storage	32GB eMMC	32GB SSD	32GB SSD
Battery type	3-cell Li-Polymer	3-cell Li-Polymer	3-cell Li-Polymer
Display	11.6" (1,366 × 768)	11.6" (1,366 × 768)	11.6" (1,366 × 768)
Wireless	802.11b/g/n	802.11a/b/g/n	802.11a/b/g/n
Bluetooth®	4.0	4.0	4.0
USB ports	1 × USB 3.0 1 × USB 2.0	1 × USB 3.0 1 × USB 2.0	1 × USB 3.0 1 × USB 2.0
System weight	2.8 lbs.	2.98 lbs.	2.87 lbs.
OS	Windows 8.1	Chrome OS 42.0.2311.153	Chrome OS 42.0.2311.153
Firmware	N/A	Google_Peppy.6812.88.0	Google_Peppy.6812.88.0
Pricing			
MSRP on 6/24/15	$199.99	$299.99	$349.99

Figure 19: Detailed configuration information and pricing for the three test systems. Prices represent manufacturer's suggested retail price for the test systems as of June 15, 2015.

Microsoft Windows 8.1 notebook vs. Chromebooks for education

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APPENDIX B – DETAILED TEST METHODOLOGY

ONLINE SCENARIOS

Doing science classwork

1. Launch Word 2013 / Google Docs. Start the timer when you click the icon, and stop timing once the application fully loads.
2. Choose to open a new document from the list of options provided. Start the timer when clicking to create a blank document, and stop the timer once the new document has fully loaded and gives you a cursor (on Windows) or once the page fully loads and the "Comment" button is no longer grayed out (in Google Docs).
3. Launch Kno Textbook app on Windows or navigate to www.kno.com/account/courseManager on the Chromebooks. Start the timer while launching the app or website and stop the timer once it fully loads.
4. Open sample Biology textbook. Start the timer when clicking on the textbook in question and stop the timer once the textbook has fully loaded.
5. Open the class notes .pptx file (PowerPointPPTX.pptx – 2.29MB) in PowerPoint 2013 / Google Slides to study. Start the timer while launching the document and stop the timer once the file has fully loaded (when the Present button is no longer grayed out on Google Docs).
6. Open PhET Build an Atom by navigating to phet.colorado.edu/sims/html/build-an-atom/latest/build-an-atom_en.html in Google Chrome™. Start the timer when the website is launched, and stop the timer when the interactive application finishes loaded and shows a menu.

Studying for a science test

1. Launch Word 2013 / Google Docs. Start the timer when you click the icon, and stop the timer once the application fully loads.
2. Choose to open a new document from the list of options provided. Start the timer when clicking to create a blank document, and stop the timer once the new document has fully loaded and gives you a cursor (on Windows) or once the page fully loads and the "Comment" button is no longer grayed out (in Google Docs).
3. Open the Khan Academy app on Windows or navigate to www.khanacademy.org/ on the Chromebooks. Start the timer when launching the app or website, and stop once it has fully loaded (once the favicon replaces the loading symbol in Chrome).
4. Navigate to Science → Biology → Human Biology and watch the "Anatomy of a Neuron" Khan Academy lesson. Start the timer when clicking on that specific lesson and stop the timer once the video has fully loaded.
5. Launch BioDigital Human by navigating to human.biodigital.com/ in Google Chrome. Start the timer when launching the website, and stop the timer once the loading icon reaches 100 percent and disappears.
6. View the interactive Alzheimer's Condition in BioDigital Human by navigating to Conditions → Brain and Nerves → Alzheimer's Disease on the menu to the left. Start the timer when clicking on the specific condition, and stop once the loading icon disappears.
7. View the interactive Aphasia Condition in BioDigital Human by navigating to Conditions → Brain and Nerves → Aphasia on the menu to the left. Start the timer when clicking on the specific condition, and stop once the loading icon disappears.

Completing a math assignment

1. Open an existing .xlsx file (ExcelXLSX2.xlsx – 168KB) in Excel 2013 / Google Sheets. Start the timer while clicking to open the document, and stop the timer once the document has fully loaded.
2. (Chromebooks only) Convert .xlsx to .gsheets file for editing by clicking File → Save as Google Sheets in Google Sheets. Start the timer when clicking Save as Google Sheets, and stop the timer once the new .gsheets version of the file has opened and finished loading completely.
3. Generate a chart from the dataset in Excel 2013 and Google Sheets by selecting the cell range E12 – K1754 and clicking Insert → Chart. Start the timer when clicking Insert → Chart, and stop the timer when the chart has finished generating.
4. Launch Word 2013 / Google Docs. Start the timer when you click the icon, and stop the timer once the application fully loads.
5. Choose to open a new document from the list of options provided. Start the timer when clicking to create a blank document and stop the timer once the new document has fully loaded and gives you a cursor (on Windows) or once the page fully loads and the "Comment" button is no longer grayed out (in Google Docs).
6. Copy and paste the newly generated chart from Excel 2013 / Google Sheets into the blank Word 2013 / Google Docs file. Start the timer when you click Paste, and stop the timer when the chart appears in the document.
7. Launch the GeoGebra app. Start the timer when clicking to launch the application, and stop the timer once it fully loads and presents you with the main menu.
8. Save the Word 2013 / Google Doc file to PDF. Start the timer when clicking "Save" or "Download as PDF" (for Chromebooks), and stop the timer when the file has successfully saved or downloaded.

Researching and writing a paper

1. Open class notes in OneNote/Evernote. Start the timer when clicking to launch the application, and stop the timer once the default notebook has fully loaded.
2. Open class notes .pptx file (PowerPointPPTX.pptx – 2.29MB) in PowerPoint 2013 / Google Slides to study. Start the timer while launching the document, and stop the timer once the file has fully loaded (when the Present button is no longer grayed out on Google Docs).
3. Launch Word 2013 / Google Docs. Start the timer when you click the icon, and stop the timer once the application fully loads.
4. Choose to open a new document from the list of options provided. Start the timer when clicking to create a blank document, and stop the timer once the new document has fully loaded and gives you a cursor (on Windows) or once the page fully loads and the "Comment" button is no longer grayed out (in Google Docs).
5. Launch Paint (on Windows) or CloudConvert (Chromebook app). Start the timer when the application launches, and stop the timer once it has fully loaded.
6. Open the 26.1MB IMG_9054.png image file in Paint or Cloud Convert and save/convert it to JPG format. Start the timer when clicking Save (or Convert) and stop the timer once the converted file has successfully saved (in Paint) or once it has been converted and successfully uploaded back to Google Drive (CloudConvert).

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7. Insert the converted IMG_9054.jpg image into the blank Word 2013 / Google Docs document by clicking Insert → Image in Google Docs or Insert → Pictures in Word 2013. Start the timer once the image has been selected for insertion, and stop the timer once it appears in the document body.

8. Open MindMeister by launching the app from the Chromebook app menu or by navigating to www.mindmeister.com/#all. Start the timer when clicking to launch the app or website, and stop the timer once the website has fully loaded.

9. Create new Mind Map for brainstorming by clicking "New Mind Map" and selecting the "Blank" template. Start the timer when clicking on the "Blank" template and stop once the loading icon on the new Mind Map disappears and the page has fully loaded.

10. Launch Skype / Google Hangouts for peer review. Start the timer when clicking to launch the application, and stop the timer once it has fully loaded.

OFFLINE SCENARIOS

Editing a slideshow

1. Open an existing .pptx/.gslides file (2.29MB PowerPointPPTX.pptx or its pre-converted .gslides equivalent) in PowerPoint 2013 / Google Slides. Start the timer when clicking to open the file, and stop once it has fully loaded in the application.

2. Open an image (6.46MB IMG_9054.jpg) in the Microsoft Photo Gallery application or the Google Drive photo viewer. Start the timer when clicking to open the image file, and stop the timer once it has fully loaded in the application.

3. Touch up the image by clicking Edit and then Auto-adjust/auto-fix. Start the timer when clicking on the Auto-adjust or Auto-fix icon. Stop the timer once the image has been modified and automatically saves.

4. Insert the image into the .pptx/.gslides file by clicking Insert → Image (Chromebooks) or Insert → Pictures (Windows). Start the timer after confirming the image selected for insertion, and stop the timer once it appears in the slideshow presentation.

Completing an English assignment

1. Open class notes in OneNote/Evernote. Start the timer when clicking to launch the application, and stop the timer once the default notebook has fully loaded.

2. Launch Word 2013 / Google Docs. Start the timer when you click the icon, and stop the timer once the application fully loads.

3. Choose to open a new document from the list of options provided. Start the timer when clicking to create a blank document, and stop the timer once the new document has fully loaded and gives you a cursor (on Windows) or once the page fully loads and the "Comment" button is no longer grayed out (in Google Docs).

4. Open the class notes .pptx file (PowerPointPPTX.pptx – 2.29MB) in PowerPoint 2013 / Google Slides to study. Start the timer while launching the document, and stop the timer once the file has fully loaded (when the Present button is no longer grayed out on Google Docs).

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5. Open an image (6.46MB IMG_9054.jpg) in the Microsoft Photo Gallery application or the Google Drive photo viewer. Start the timer when clicking to open the image file, and stop the timer once it has fully loaded in the application.
6. Touch up the image by clicking Edit and then Auto-adjust/auto-fix. Start the timer when clicking on the Auto-adjust or Auto-fix icon. Stop the timer once the image has been modified and automatically saves.
7. Insert the modified image into the new blank Word 2013 or Google Docs file by clicking Insert → Image (Chromebooks) or Insert → Pictures (Windows). Start the timer after confirming the image selected for insertion, and stop the timer once it appears in the document.

Completing math homework

1. Open an existing .xlsx file (ExcelXLSX2.xlsx – 168KB) or its pre-converted .gsheets equivalent in Excel 2013 / Google Sheets. Start the timer while clicking to open the document, and stop the timer once the document has fully loaded.
2. Generate a chart from dataset in Excel 2013 and Google Sheets by selecting the cell range E12 – K1754 and clicking Insert → Chart. Start the timer when clicking Insert → Chart, and stop the timer when the chart has finished generating.
3. Launch the GeoGebra app. Start the timer when clicking to launch the application, and stop the timer once it fully loads and presents you with the main menu.
4. Launch Word 2013 / Google Docs. Start the timer when you click the icon, and stop the timer once the application fully loads.
5. Choose to open a new document from the list of options provided. Start the timer when clicking to create a blank document, and stop the timer once the new document has fully loaded and gives you a cursor (on Windows) or once the page fully loads and the "Comment" button is no longer grayed out (in Google Docs).

Creating a science lab report

1. Open a class notes .pptx file (PowerPointPPTX.pptx – 2.29MB) in PowerPoint 2013 / Google Slides to study. Start the timer while launching the document, and stop the timer once the file has fully loaded (when the Present button is no longer grayed out on Google Docs).
2. Open an existing .xlsx file (ExcelXLSX2.xlsx – 168KB) in Excel 2013 / Google Sheets. Start the timer while clicking to open the document, and stop the timer once the document has fully loaded.
3. Launch Word 2013 / Google Docs. Start the timer when you click the icon, and stop the timer once the application fully loads.
4. Choose to open a new document from the list of options provided. Start the timer when clicking to create a blank document, and stop the timer once the new document has fully loaded and gives you a cursor (on Windows) or once the page fully loads and the "Comment" button is no longer grayed out (in Google Docs).
5. Launch the Anatronica application. Start the timer when clicking to launch the application, and stop the timer once the Anatronica interactive Unity3D application-loading bar is complete and the menu to select skeletal gender appears.

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APPENDIX C – DETAILED RESULTS

Figures 20-21 present the results of our testing.

	HP Stream 11	Acer C720P w/ 2GB	Acer C720P w/ 4GB
Offline scenario 1: Editing a slideshow			
Open existing .pptx /.gslides file			
Run 1	3.72	7.73	7.71
Run 2	3.78	7.85	7.71
Run 3	3.68	7.69	7.75
Median	3.72	7.73	7.71
Open image in Photo Gallery / Google Drive			
Run 1	1.56	2.41	2.31
Run 2	1.54	2.39	2.31
Run 3	1.53	2.45	2.31
Median	1.54	2.41	2.31
Auto-adjust / auto-fix image			
Run 1	1.53	2.73	1.49
Run 2	1.55	2.71	1.55
Run 3	1.53	2.83	1.57
Median	1.53	2.73	1.55
Insert image into presentation			
Run 1	2.00	1.65	1.56
Run 2	2.05	1.62	1.53
Run 3	1.95	1.64	1.52
Median	2.00	1.64	1.53
Scenario total	**8.79**	**14.51**	**13.10**
Offline scenario 2: Completing an English assignment			
Open OneNote / Evernote			
Run 1	2.01	2.20	2.06
Run 2	2.00	2.15	2.16
Run 3	2.05	2.15	2.07
Median	2.01	2.15	2.07
Launch Word 2013 / Google Docs			
Run 1	2.26	2.90	2.72
Run 2	2.28	2.77	2.76
Run 3	2.27	2.79	2.79
Median	2.27	2.79	2.76

Microsoft Windows 8.1 notebook vs. Chromebooks for education

A Principled Technologies test report **22**

	HP Stream 11	Acer C720P w/ 2GB	Acer C720P w/ 4GB
Open new blank document			
Run 1	1.50	4.18	4.18
Run 2	1.48	4.05	4.07
Run 3	1.45	4.16	4.12
Median	1.48	4.16	4.12
Open class notes .pptx file			
Run 1	3.56	3.23	3.92
Run 2	3.58	3.15	3.96
Run 3	3.69	3.21	3.88
Median	3.58	3.21	3.92
Open image in Photo Gallery / Google Drive			
Run 1	1.68	2.58	2.31
Run 2	1.62	2.51	2.33
Run 3	1.63	2.47	2.32
Median	1.63	2.51	2.32
Auto-adjust / auto-fix image			
Run 1	1.54	1.58	1.47
Run 2	1.53	1.65	1.54
Run 3	1.56	1.66	1.46
Median	1.54	1.65	1.47
Insert image into document			
Run 1	1.89	1.45	1.57
Run 2	1.90	1.44	1.52
Run 3	1.90	1.42	1.49
Median	1.90	1.44	1.52
Scenario total	**14.41**	**17.91**	**18.18**
Offline scenario 3: Completing math homework			
Open existing .xlsx / .gsheets file			
Run 1	1.93	7.99	7.99
Run 2	1.88	8.01	8.03
Run 3	1.84	7.91	7.72
Median	1.88	7.99	7.99
Generate chart from data			
Run 1	1.28	2.15	1.98
Run 2	1.32	2.21	1.91
Run 3	1.31	2.24	1.92
Median	1.31	2.21	1.92

Microsoft Windows 8.1 notebook vs. Chromebooks for education

A Principled Technologies test report 23

	HP Stream 11	Acer C720P w/ 2GB	Acer C720P w/ 4GB
Launch GeoGebra			
Run 1	1.13	0.80	0.70
Run 2	1.09	0.81	0.70
Run 3	1.15	0.78	0.72
Median	1.13	0.80	0.70
Launch Word 2013 / Google Docs			
Run 1	2.25	3.14	3.18
Run 2	2.15	3.15	3.11
Run 3	2.19	3.08	3.12
Median	2.19	3.14	3.12
Open new blank document			
Run 1	1.34	4.16	3.78
Run 2	1.32	4.07	3.72
Run 3	1.28	4.07	3.83
Median	1.32	4.07	3.78
Scenario total	**7.83**	**18.21**	**17.51**
Offline scenario 4: Creating a science lab report			
Open class notes .pptx file			
Run 1	3.25	3.37	4.06
Run 2	3.23	3.25	4.08
Run 3	3.34	3.34	4.00
Median	3.25	3.34	4.06
Open existing .xlsx file			
Run 1	2.59	4.21	4.07
Run 2	2.57	4.14	3.95
Run 3	2.50	4.07	4.00
Median	2.57	4.14	4.00
Launch Word 2013 / Google Docs			
Run 1	2.64	2.86	3.09
Run 2	2.68	2.74	3.07
Run 3	2.59	2.74	3.04
Median	2.64	2.74	3.07
Open new blank document			
Run 1	1.57	3.86	3.63
Run 2	1.54	3.82	3.82
Run 3	1.50	3.65	3.61
Median	1.54	3.82	3.63

Microsoft Windows 8.1 notebook vs. Chromebooks for education

A Principled Technologies test report 24

	HP Stream 11	Acer C720P w/ 2GB	Acer C720P w/ 4GB
Launch Anatronica			
Run 1	5.88	9.05	9.12
Run 2	5.92	8.87	8.84
Run 3	5.97	8.87	8.90
Median	5.92	8.87	8.90
Scenario total	**15.92**	**22.91**	**23.66**

Figure 20: Detailed results for the offline scenarios in seconds.

Microsoft Windows 8.1 notebook vs. Chromebooks for education

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	HP Stream 11	Acer C720P w/ 2GB	Acer C720P w/ 4GB
Online scenario 1: Doing science classwork			
Launch Word 2013 / Google Docs			
Run 1	1.90	3.90	3.87
Run 2	1.90	3.85	3.89
Run 3	1.87	3.96	3.84
Median	1.90	3.90	3.87
Open new blank document			
Run 1	1.38	4.44	4.39
Run 2	1.31	4.56	4.37
Run 3	1.36	4.68	4.61
Median	1.36	4.56	4.39
Launch Kno Textbook			
Run 1	2.37	3.70	3.57
Run 2	2.34	3.79	3.67
Run 3	2.29	3.59	3.50
Median	2.34	3.70	3.57
Open "Biology" sample textbook			
Run 1	1.79	4.96	4.70
Run 2	1.76	4.99	4.57
Run 3	1.83	5.20	4.52
Median	1.79	4.99	4.57
Open class notes .pptx			
Run 1	3.38	3.36	3.18
Run 2	3.33	3.18	3.16
Run 3	3.28	3.32	3.18
Median	3.33	3.32	3.18
Open PhET Build an Atom			
Run 1	5.11	2.74	2.85
Run 2	5.17	2.87	2.81
Run 3	5.14	2.87	2.75
Median	5.14	2.87	2.81
Scenario total	**15.86**	**23.34**	**22.39**
Online scenario 2: Studying for a science test			
Launch Word 2013 / Google Docs			
Run 1	1.87	3.96	4.15
Run 2	1.91	3.98	3.99
Run 3	1.95	3.91	4.13
Median	1.91	3.96	4.13

	HP Stream 11	Acer C720P w/ 2GB	Acer C720P w/ 4GB
Open new blank document			
Run 1	1.39	4.81	4.55
Run 2	1.39	4.69	4.78
Run 3	1.40	4.62	4.56
Median	1.39	4.69	4.56
Launch Khan Academy			
Run 1	2.15	2.66	2.81
Run 2	2.15	2.68	2.71
Run 3	2.13	2.75	2.68
Median	2.15	2.68	2.71
Open "Anatomy of a Neuron" lesson			
Run 1	0.95	3.03	2.76
Run 2	0.94	3.06	2.68
Run 3	0.96	2.97	2.72
Median	0.95	3.03	2.72
Launch BioDigital Human			
Run 1	14.90	10.56	10.07
Run 2	15.12	10.71	10.00
Run 3	14.84	10.31	9.91
Median	14.90	10.56	10.00
View Alzheimer's Condition			
Run 1	2.29	2.17	2.31
Run 2	2.28	2.28	2.31
Run 3	2.26	2.19	2.24
Median	2.28	2.19	2.31
View Aphasia Condition			
Run 1	2.24	2.23	2.14
Run 2	2.18	2.21	2.23
Run 3	2.18	2.24	2.24
Median	2.18	2.23	2.23
Scenario total	**25.76**	**29.34**	**28.66**
Online scenario 3: Completing a math assignment			
Open .xlsx file			
Run 1	2.22	9.89	9.86
Run 2	2.22	10.03	9.81
Run 3	2.15	9.87	9.77
Median	2.22	9.89	9.81

	HP Stream 11	Acer C720P w/ 2GB	Acer C720P w/ 4GB
Save .xlsx as .gsheets (Chromebooks only)			
Run 1	0.00	9.12	9.16
Run 2	0.00	8.85	9.07
Run 3	0.00	8.72	8.77
Median	0.00	8.85	9.07
Generate chart from dataset			
Run 1	1.53	2.37	2.26
Run 2	1.47	2.38	2.37
Run 3	1.47	2.35	2.28
Median	1.47	2.37	2.28
Launch Word 2013 / Google Docs			
Run 1	2.15	4.46	4.42
Run 2	2.13	4.31	4.36
Run 3	2.25	4.33	4.20
Median	2.15	4.33	4.36
Open new blank document			
Run 1	1.21	4.76	4.64
Run 2	1.21	4.85	4.64
Run 3	1.17	4.81	4.43
Median	1.21	4.81	4.64
Copy and paste chart into document			
Run 1	1.70	1.28	1.09
Run 2	1.64	1.28	1.06
Run 3	1.71	1.30	1.07
Median	1.70	1.28	1.07
Launch GeoGebra			
Run 1	1.16	0.85	0.81
Run 2	1.14	0.83	0.81
Run 3	1.17	0.87	0.83
Median	1.16	0.85	0.81
Save document as PDF			
Run 1	1.33	2.08	1.81
Run 2	1.27	2.11	1.79
Run 3	1.28	2.09	1.81
Median	1.28	2.09	1.81
Scenario total	**11.19**	**34.47**	**33.85**

	HP Stream 11	Acer C720P w/ 2GB	Acer C720P w/ 4GB
Online scenario 4: Researching and writing a paper			
Open OneNote / Evernote			
Run 1	1.46	2.14	2.00
Run 2	1.54	2.12	2.11
Run 3	1.47	2.09	2.00
Median	1.47	2.12	2.00
Open class notes .pptx			
Run 1	2.64	3.23	3.06
Run 2	2.63	3.12	2.97
Run 3	2.73	3.09	2.96
Median	2.64	3.12	2.97
Launch Word 2013 / Google Docs			
Run 1	1.94	4.12	4.10
Run 2	1.97	4.31	4.16
Run 3	1.93	4.12	4.09
Median	1.94	4.12	4.10
Open new blank document			
Run 1	1.10	4.74	4.66
Run 2	1.14	4.49	4.57
Run 3	1.12	4.56	4.70
Median	1.12	4.56	4.66
Launch Paint / CloudConvert			
Run 1	0.57	2.70	2.57
Run 2	0.59	2.69	2.62
Run 3	0.56	2.81	2.69
Median	0.57	2.70	2.62
Convert 26.1MB PNG to JPG			
Run 1	1.67	7.78	7.64
Run 2	1.71	8.04	7.73
Run 3	1.70	7.67	7.37
Median	1.70	7.78	7.64
Insert converted image into document			
Run 1	2.01	2.39	1.72
Run 2	1.93	2.30	1.68
Run 3	1.96	2.28	1.76
Median	1.96	2.30	1.72

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	HP Stream 11	Acer C720P w/ 2GB	Acer C720P w/ 4GB
Open MindMeister			
Run 1	5.20	3.12	2.87
Run 2	5.12	3.01	2.88
Run 3	5.10	3.06	2.90
Median	5.12	3.06	2.88
Create new blank Mind Map			
Run 1	3.08	2.05	2.25
Run 2	3.19	2.10	2.30
Run 3	3.20	2.03	2.22
Median	3.19	2.05	2.25
Launch Skype / Google Hangouts			
Run 1	3.33	3.71	3.79
Run 2	3.44	3.78	3.70
Run 3	3.48	3.59	3.59
Median	3.44	3.71	3.70
Scenario total	**23.15**	**35.52**	**34.54**

Figure 21: Detailed results for the online scenarios in seconds.

ABOUT PRINCIPLED TECHNOLOGIES

Principled Technologies®

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We provide industry-leading technology assessment and fact-based marketing services. We bring to every assignment extensive experience with and expertise in all aspects of technology testing and analysis, from researching new technologies, to developing new methodologies, to testing with existing and new tools.

When the assessment is complete, we know how to present the results to a broad range of target audiences. We provide our clients with the materials they need, from market-focused data to use in their own collateral to custom sales aids, such as test reports, performance assessments, and white papers. Every document reflects the results of our trusted independent analysis.

We provide customized services that focus on our clients' individual requirements. Whether the technology involves hardware, software, websites, or services, we offer the experience, expertise, and tools to help our clients assess how it will fare against its competition, its performance, its market readiness, and its quality and reliability.

Our founders, Mark L. Van Name and Bill Catchings, have worked together in technology assessment for over 20 years. As journalists, they published over a thousand articles on a wide array of technology subjects. They created and led the Ziff-Davis Benchmark Operation, which developed such industry-standard benchmarks as Ziff Davis Media's Winstone and WebBench. They founded and led eTesting Labs, and after the acquisition of that company by Lionbridge Technologies were the head and CTO of VeriTest.