HP CHROMEBOOK 14 G1 IN THE CLASSROOM

Give students more time for learning
with the HP Chromebook™ 14 G1* powered by Intel®

41% less waiting
while learning in science class

34% less waiting
while creating a history project

Better visual experience
in Google Maps™ and BioDigital Human

*versus the NVIDIA® Tegra® K1 processor-based Chromebook we tested

Chromebooks need fast processors to keep up with students in today's classroom, when every second matters. Slow systems disrupt and frustrate students, who should stay engaged in the classroom. Teachers also want this—engaged students are more productive and ultimately have more time for active learning.

In the Principled Technologies labs, we put two Chromebooks to the test in science class and history project scenarios with commonly used apps such as BioDigital Human, Google Docs™, Glogster™, and PicMonkey™.

The results were clear: the Intel processor-powered HP Chromebook 14 G1 provided a significantly better experience for students than the NVIDIA Tegra K1 processor-based Acer® Chromebook 13. In our two scenarios, students would save valuable classroom time with the HP Chromebook 14 G1—41 percent less waiting while learning in science class and 34 percent less waiting while creating a history project. The HP Chromebook 14 G1 also delivered a smoother and more responsive experience in BioDigital Human and Google Maps, rendering up to 79 percent more frames per second.

The time that the HP Chromebook 14 G1 saves students can add up during a class period, leaving more time for learning and promoting a more engaged classroom. The bottom line: in our tests, the Intel processor-powered HP Chromebook 14 G1 provided a better learning experience when put to the test with common classroom tasks.

THE PROCESSOR INSIDE A CHROMEBOOK MATTERS

The components inside your Chromebook can make all the difference in how your device performs. The processor that drives these devices is key to getting the performance you want. We compared the Intel processor-powered HP Chromebook 14 G1 against the NVIDIA Tegra K1 processor-based Acer Chromebook 13 to help you get the facts and make the right choice for your school. For details about the systems we tested, see Appendix A. If you want to learn more about our test process, go to Appendix B.

Less waiting for learning in science class with the HP Chromebook 14 G1

Mia's science class begins with an icebreaker: she and a partner have four minutes to name as many bones in the human body as possible. Mia opens Google Docs and shares a new document with her partner, and they work together to complete the assignment. After the activity, Mia's teacher starts a lesson on human anatomy, and Mia follows along in a Google Slides presentation. Then, Mia's class looks at BioDigital Human, and Mia opens the app to view a couple conditions with her class. While working in BioDigital Human, Mia and her classmates use Glogster to create a Glog® about the conditions. At the end of class, Mia and her classmates are given time to work on an anatomy lesson in Khan Academy®. Mia opens Edmodo® and checks her planner to open the link to the Khan Academy assignment.

Less waiting = more time for learning in science class

Intel 59.9s

NVIDIA 102.7s

(lower is better)

41% less waiting

1   Create new document in Google Docs
2   Open presentation in Google Slides
3   Open BioDigital Human
4   Switch skeleton model in BioDigital Human
5   Open Glogster

6   Create new Glog in Glogster
7   Load condition in BioDigital Human
8   Open Edmodo
9   Check assignment in Edmodo planner
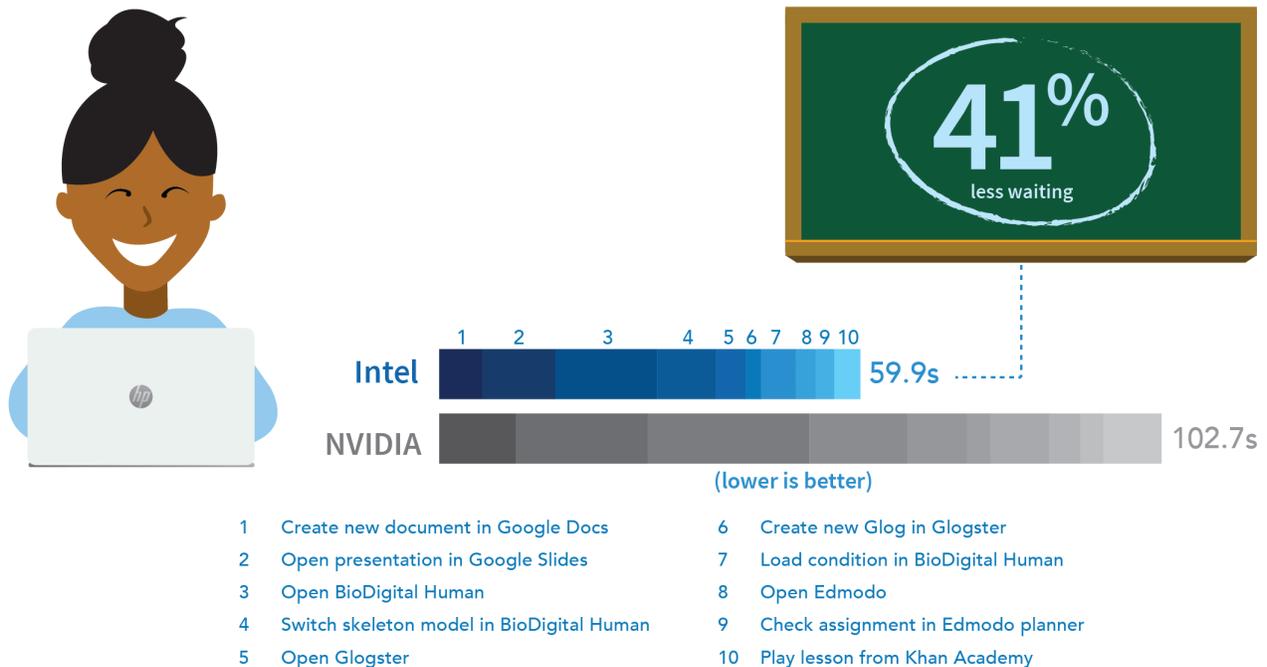10   Play lesson from Khan Academy

Figure 1: The Intel processor-powered HP Chromebook 14 G1 outperformed the NVIDIA Tegra K1 processor-based Acer Chromebook 13 in our science class scenario.

> **Mia would save well over 8 seconds each time she opens the Google Slides presentation with the HP Chromebook 14 G1.**

As Figure 1 shows, Mia would save valuable time with the Intel processor-powered HP Chromebook 14 G1 while learning anatomy in science class—over 42 seconds in our scenario. For Mia's teacher, that time saved would quickly add up and ultimately mean more time for teaching the lesson. Mia would save well over 8 seconds each time she opens the Google Slides presentation with the HP Chromebook 14 G1. She would have to wait 8 seconds longer each time she opens BioDigital Human with the NVIDIA Tegra K1 processor-based Chromebook, and would also lose time switching the skeleton model or loading a condition.

More frames per second = better visual experience in BioDigital Human

Intel — 55.1 fps ----- **79%** more frames per second
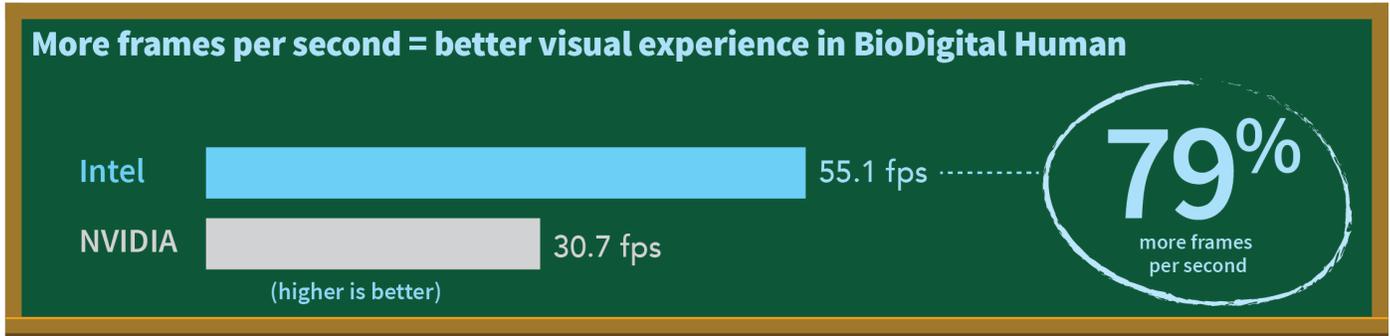
NVIDIA — 30.7 fps

(higher is better)

Figure 2: The Intel processor-powered HP Chromebook 14 G1 delivered more frames per second than the NVIDIA Tegra K1 processor-based Acer Chromebook 13 when rotating the skeleton model in BioDigital Human.

As Figure 2 shows, the Intel processor-powered HP Chromebook 14 G1 also rendered 79 percent more frames per second when rotating the skeleton model in the BioDigital Human app to give Mia a smoother and more responsive experience than with the NVIDIA Tegra K1 processor-based Acer Chromebook 13.

Less waiting for creating a history project with the HP Chromebook 14 G1

Brandon and his classmates are working on a US history video project. He opens a new WeVideo® project and starts gathering facts about the Declaration of Independence in Google Docs. He makes title cards in WeVideo and starts writing a script to narrate the video. A quick Wikipedia® search tells Brandon that Independence Hall in Philadelphia is the birthplace of the American government, so he opens Google Maps™ and uses Street View™ to tour the site. He uses the PicMonkey Extension to take screenshots of the building to include in his video. Before saving the photos to his Google Drive, Brandon edits the images with the PicMonkey app. He picks his two favorite images in the Gallery app and uploads them to WeVideo, where he adds transitions to the images in the video timeline. Brandon publishes a rough draft to his Google Drive™ and previews his video presentation.
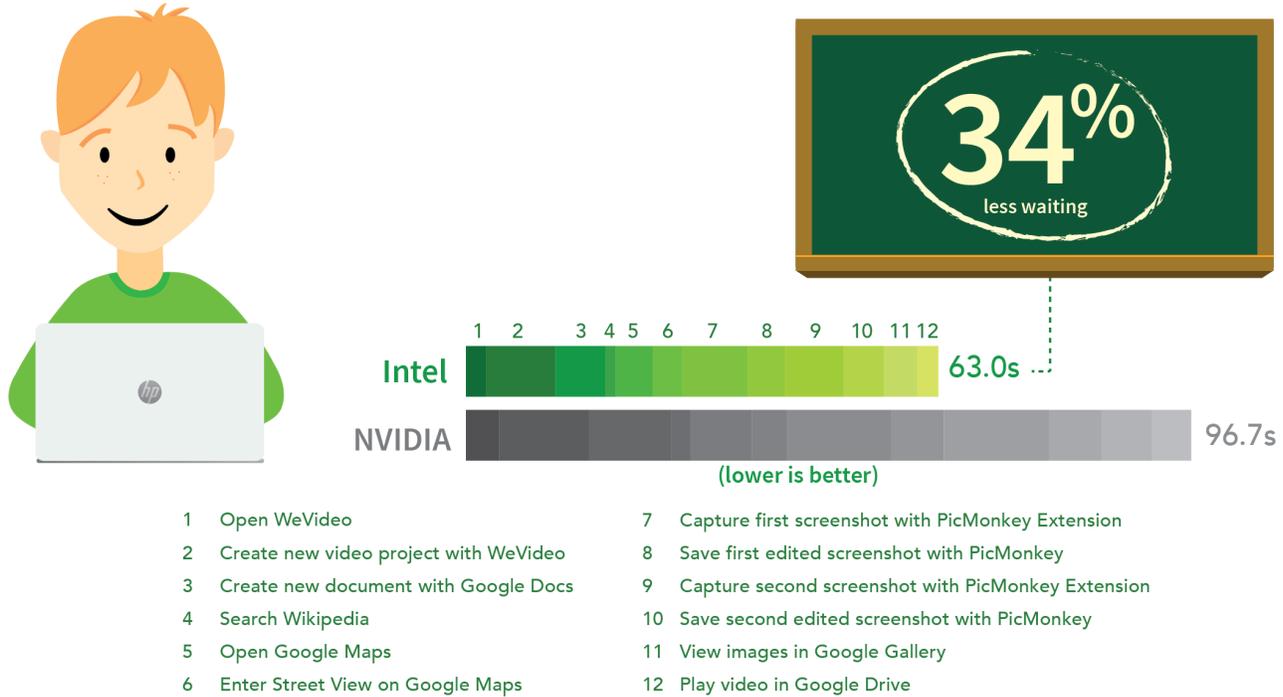
Less waiting = more time for creating a history project

34% less waiting

	1 2 3 4 5 6 7 8 9 10 11 12	
Intel		63.0s
NVIDIA		96.7s

(lower is better)

1	Open WeVideo	7	Capture first screenshot with PicMonkey Extension
2	Create new video project with WeVideo	8	Save first edited screenshot with PicMonkey
3	Create new document with Google Docs	9	Capture second screenshot with PicMonkey Extension
4	Search Wikipedia	10	Save second edited screenshot with PicMonkey
5	Open Google Maps	11	View images in Google Gallery
6	Enter Street View on Google Maps	12	Play video in Google Drive

Figure 3: The Intel processor-powered HP Chromebook 14 G1 outperformed the NVIDIA Tegra K1 processor-based Acer Chromebook 13 in our history project scenario.

Brandon would save almost 15 seconds total just with PicMonkey when using the HP Chromebook 14 G1.

As Figure 3 shows, Brandon would save 33 seconds while creating his history project with the Intel processor-powered HP Chromebook 14 G1. Using the HP Chromebook 14 G1 would save Brandon time during each step in the scenario, including almost 15 seconds total just with the PicMonkey app and PicMonkey Extension. With the NVIDIA Tegra K1 processor-based Acer Chromebook 13, he would have to wait over 4 seconds longer each time he created a new document in Google Docs.

More frames per second = better visual experience in Google Maps

Intel		49.6 fps
NVIDIA		31.4 fps

(higher is better)
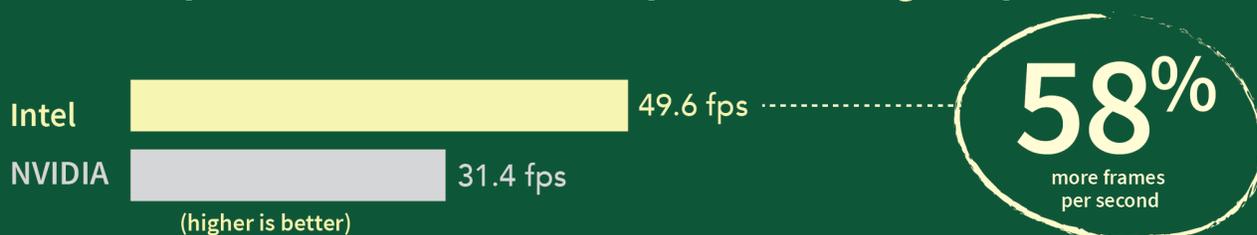
58% more frames per second

Figure 4: The Intel processor-powered HP Chromebook 14 G1 delivered more frames per second than the NVIDIA Tegra K1 processor-based Acer Chromebook 13 when zooming in Google Maps.

As Figure 4 shows, the Intel processor-powered HP Chromebook 14 G1 also rendered 58 percent more frames per second when zooming in Google Maps to give Brandon a smoother and more responsive experience. What's more: the HP Chromebook 14 G1 supported the full version of Google Maps, which means he could view 3D maps for the Earth, Mars, and the Moon if he wanted (see Figure 5). With the NVIDIA Tegra K1 processor-based Chromebook, Brandon would be limited to Lite mode, where he would be stuck viewing only basic maps and satellite footage (see Figure 6).
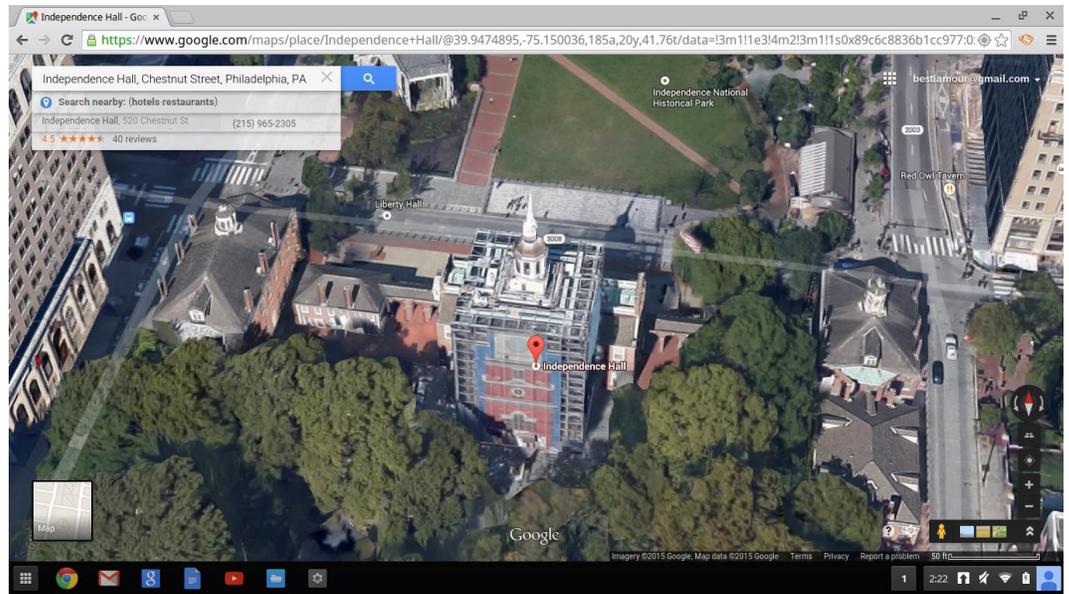
Figure 5: The Intel processor-powered HP Chromebook 14 G1 supported the full version of Google Maps.
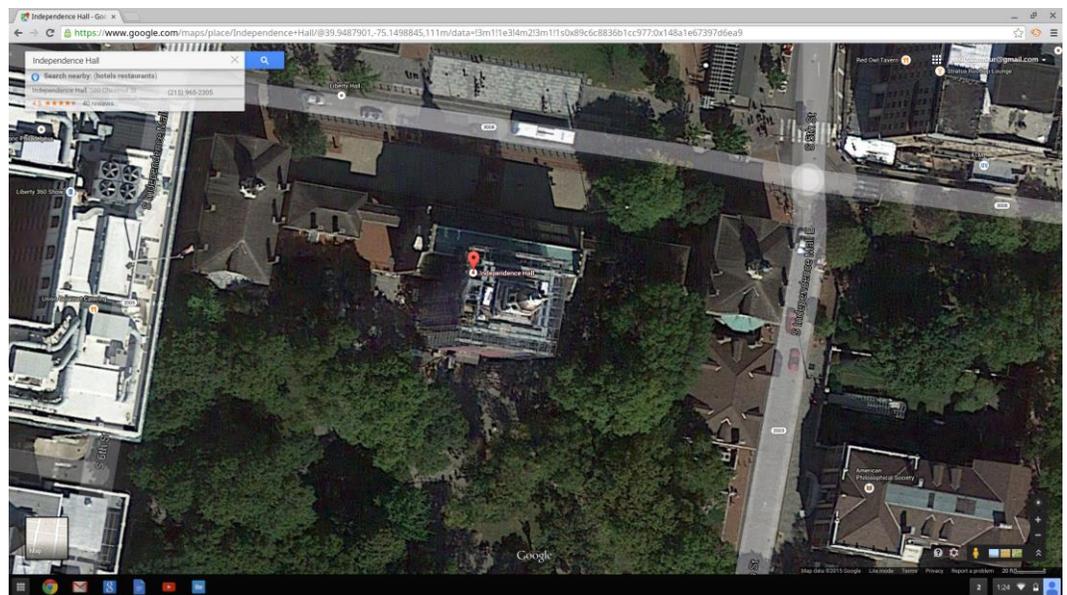
Figure 6: The NVIDIA Tegra K1 processor-based Acer Chromebook 13 limits users to Lite mode in Google maps.

CONCLUSION

Getting the most out of your students means keeping them engaged and curious in the classroom. Choosing the right Chromebook gives students the best opportunity for learning and creating by making the most of the limited amount of time available in a class period.

Our hands-on tests showed that the Intel processor-powered HP Chromebook 14 G1 would save valuable time in the classroom by reducing the amount of time students would have to wait while learning and creating. In our two scenarios, Mia would spend 41 percent less time waiting while learning anatomy in science class, and Brandon would spend 34 percent less time waiting while creating a history project. The time saved with the HP Chromebook 14 G1 amounts to more time for learning. We also found the Intel processor-powered HP Chromebook 14 G1 provided a smoother and more responsive experience in BioDigital Human and Google Maps, delivering up to 79 percent more frames per second.

Do not make your students wait on slow apps: Select the right Chromebook for your school. This decision can help students stay engaged and be more productive in the classroom, helping teachers make the most out of each classroom period.

APPENDIX A – SYSTEM CONFIGURATION INFORMATION

Figure 7 provides detailed configuration information for the test systems.

System	Intel processor-powered HP Chromebook 14 G1	NVIDIA Tegra K1 processor-based Acer Chromebook 13
Vendor and model	HP Chromebook 14 G1	Acer Chromebook 13
Processor	Intel Celeron® 2955U	NVIDIA Tegra K1 SoC
Processor frequency (GHz)	1.4	2.1
Processor cores	2	4
Memory (GB)	4	4
Storage (GB)	16	32
Battery type	4-Cell Li-ion	4-cell Li-ion
Battery capacity	51 Wh	47 Wh
Display	14.0" (1,366 × 768)	13.3" (1,920 × 1,080)
Wireless	802.11 a/b/g/n	802.11ac (802.11 a/b/g/n compatible)
Bluetooth®	Bluetooth 4.0	Bluetooth 4.0
USB 3.0 ports	2	2
System weight (lbs.)	4.08	3.16
OS	Chrome OS™ version 40.0.2214.114	Chrome OS version 40.0.2214.114
Release version	6457.94.0 falco	6457.94.0 nyan_big

Figure 7: Detailed configuration information for the Chromebooks.

APPENDIX B – HOW WE TESTED

Configuring Chromebooks for testing

1. Power on the Chromebook.
2. Log in with a Google account.
3. In the bottom right corner, click the user account icon.
4. Click Settings.
5. Click Show advanced settings…
6. In the Powerwash section, click Powerwash.
7. Click Restart. The system will reboot into the Powerwash settings.
8. Click Powerwash.
9. Click Continue.
10. When the Powerwash is complete, the system will reboot to the initial setup wizard.
11. Set the language (English) and keyboard layout (US).
12. Select a network and enter the network credentials.
13. Click Continue.
14. Click Accept and continue.
15. Log in with the test account.
16. Click the Chrome™ icon to open Google Chrome™.
17. Navigate to chrome://system.
18. Report the ChromeOS Version and ChromeOS Release Version for each system.
19. Close Google Chrome.

Learning anatomy in science class scenario

Prior to testing, we installed the following apps from the Google Chrome Web Store: BioDigital Human, Glogster EDU, Edmodo, and Khan Academy. We created test accounts and performed first-time logins for all apps. We closed or disabled any welcome screens. For Edmodo, we created an additional Teacher account to issue assignments to Student accounts. For steps 5 through 7, we saved a Microsoft® PowerPoint® presentation as a Google Slides presentation on each system. We used the following presentation as our sample presentation:

www.lavc.edu/instructor/watson_k/docs/Introduction%20to%20Anatomy.ppt

1. Simultaneously start the timer and click the Google Docs icon in the shelf.
2. When the page loads, click the + icon.
3. When the new document is fully loaded (when the Comments button changes to the active state), stop the timer. Record the result.
4. Click the apps icon.
5. Simultaneously start the timer and click Google Slides.
6. When the page loads, click the Introduction to Anatomy presentation.
7. When the presentation is fully loaded (when the Comments button changes to the active state and all slide thumbnails are loading), stop the timer. Record the result.
8. Simultaneously start the timer and click BioDigital Human.
9. Click Log in.
10. When the model and list of systems are fully loaded, stop the timer. Record the result.
11. To select the current skeleton model, click the Male drop-down menu.
12. Simultaneously click Female and start the timer.

13. When the model and list of systems is fully loaded, stop the timer. Record the result.
14. Click the apps icon.
15. Simultaneously start the timer and click Glogster EDU.
16. When the page is fully loaded, stop the timer. Record the result.
17. Click Create New Glog.
18. Simultaneously start the timer and click the Experimental template.
19. When all graphics have finished loading, stop the timer. Record the result.
20. Click the BioDigital Human tab.
21. Click Conditions.
22. Simultaneously start the timer and click Ear, Nose and Throat.
23. Click Allergic Rhinitis.
24. When the condition animation completes, and the text description is fully loaded, stop the timer. Record the result.
25. Click the apps icon.
26. Simultaneously start the timer and click Edmodo.
27. When the page is fully loaded, stop the timer. Record the result.
28. Simultaneously start the timer and click the calendar (planner) icon.
29. Click on the assignment due tomorrow (February 3, 2015).
30. When the pop-up fully loads, stop the timer. Record the result.
31. Simultaneously start the timer and click the assignment link to the Anatomy of a neuron lesson (www.khanacademy.org/science/biology/human-biology/neuron-nervous-system/v/anatomy-of-a-neuron).
32. When the page loads, click the play icon.
33. When video playback begins, stop the timer. Record the result.

Measuring average FPS in BioDigital Human

For this test, we used Google Chrome's FPS tool and a photo intervalometer (time-lapse) application on a smartphone to take 25 photos of the systems' screens over the span of 60 seconds. We recorded and averaged the results of the 25 screenshots.

1. In Google Chrome, navigate to chrome://flags.
2. Under FPS counter, click Enable.
3. Click Restart Now.
4. Close Chrome.
5. Click the apps icon.
6. Click BioDigital Human.
7. Click Log In, and enter user credentials if necessary.
8. Select the Anatomy tab.
9. Click Skeletal System.
10. Click Bones of the Upper Limb.
11. Click Bones of the Right Arm.
12. Position the camera to take screenshots of the FPS counter.
13. To begin model rotation and start the time-lapse, hold down the arrow key.
14. After 60 seconds have elapsed, stop the time-lapse.
15. Record the FPS reported for each frame.
16. Navigate to chrome://flags.
17. Under FPS counter, click Disable.
18. Click Restart Now.
19. Close Chrome.

Creating videos for a history project scenario

Prior to testing, we installed the following apps from the Google Chrome Web Store: WeVideo – Video Editor and Maker, PicMonkey, and PicMonkey Extension. We created test accounts and performed first-time logins for all apps. We closed or disabled any welcome screens.

1. Click the apps icon.
2. Simultaneously start the timer and click WeVideo – Video Editor and Maker.
3. When the page is fully loaded, stop the timer. Record the result.
4. Click New Project.
5. Enter a name for the new project (History Project).
6. Simultaneously start the timer and click Create.
7. When the project is created, hover over the project name and click Create New Video.
8. When the editor fully loads, stop the timer. Record the result.
9. Simultaneously start the timer and click the Google Docs icon in the shelf.
10. When the page loads, click the + icon.
11. When the new document is fully loaded (when the Comments button changes to the active state), stop the timer. Record the result.
12. Open a new tab and navigate to Wikipedia.org.
13. In the search bar, type the phrase `Independence Hall`.
14. Simultaneously start the timer and press enter.
15. When the page is fully loaded, stop the timer. Record the result.
16. Click the apps icon.
17. Simultaneously start the timer and click Google Maps.
18. When Google Maps is fully loaded (when the Satellite/Earth box is loading), stop the timer. Record the result.
19. Search for Independence Hall.
20. Click and drag the Street View pegman to the Independence Hall marker.
21. Simultaneously release the pegman on the marker and start the timer.
22. When Street View fully loads and all page elements are displayed, stop the timer. Record the result.
23. Click Hide imagery.
24. Simultaneously click the PicMonkey Extension icon and start the timer.
25. Click the captured screenshot.
26. Stop the timer when the editor fully loads. Record the result.
27. Click Auto adjust.
28. Click Save.
29. Simultaneously start the timer and click Save to my computer.
30. Click Save.
31. When Masterpiece Saved appears, stop the timer. Record the result.
32. To return to Google Maps, close the tab.
33. Click the Show Imagery icon.
34. Click the Independence National Historical Park photo.
35. Click Hide imagery.
36. Simultaneously click the PicMonkey Extension icon and start the timer.
37. Click the captured screenshot.
38. When the editor fully loads, stop the timer. Record the result.
39. Click Auto adjust.
40. Click Save.
41. Simultaneously start the timer and click Save to my computer.

42. Click Save.
43. When Masterpiece Saved appears, stop the timer. Record the result.
44. Click the apps icon.
45. Simultaneously start the timer and click Files.
46. Click to select an image, and press enter.
47. When Gallery fully loads and all thumbnails are displayed, stop the timer.
48. In a new tab, navigate to drive.google.com.
49. Click to select the video.
50. Simultaneously start the timer and press enter.
51. When video playback begins, stop the timer. Record the result.
52. Close all tabs and exit Chrome.

Measuring average FPS in Google Maps

For this test, we used Google Chrome's FPS tool and a photo intervalometer (time-lapse) application on a smartphone to take 25 photos of the systems' screens over the span of 60 seconds. We recorded and averaged the results of the 25 screenshots.

1. In Google Chrome, navigate to chrome://flags.
2. Under FPS counter, click Enable.
3. Click Restart Now.
4. Close Chrome.
5. Click the apps icon.
6. Click Google Maps.
7. Zoom all the way in.
8. Position the camera to take screenshots of the FPS counter.
9. Start the time-lapse. As the test is underway, click the – symbol to zoom out. As soon as the Maps imagery is fully rendered, zoom out again. When the maximum zoom level is reached, zoom in using the same process.
10. After 60 seconds have elapsed, stop the time lapse.
11. Record the FPS reported for each frame.
12. Navigate to chrome://flags.
13. Under FPS counter, click Disable.
14. Click Restart Now.
15. Close Chrome.

APPENDIX C – DETAILED TEST RESULTS

Figure 8 and 9 present the median test results for each task in our scenarios.

Learning anatomy in science class scenario		
Task description	**Intel processor-powered HP Chromebook 14 G1**	**NVIDIA Tegra K1 processor-based Acer Chromebook 13**
Create new document in Google Docs	00:06.13	00:10.87
Open presentation in Google Slides	00:10.37	00:18.76
Open BioDigital Human	00:14.54	00:22.98
Switch skeleton model in BioDigital Human	00:08.25	00:13.96
Open Glogster EDU	00:02.22	00:03.46
Create new Glog in Glogster EDU	00:05.01	00:08.25
Load condition in BioDigital Human	00:04.25	00:08.43
Open Edmodo	00:02.81	00:04.43
Check assignment in Edmodo planner	00:02.64	00:03.35
Play a lesson from Khan Academy	00:03.66	00:08.23
Total	**00:59.88**	**01:42.72**

Figure 8: Median results for each task in our science class scenario, in minutes:seconds. Lower numbers are better.

Creating videos for a history project scenario		
Task description	**Intel processor-powered HP Chromebook 14 G1**	**NVIDIA Tegra K1 processor-based Acer Chromebook 13**
Open WeVideo	00:02.73	00:04.40
Create new video project with WeVideo	00:09.21	00:11.98
Create new document in Google Docs	00:06.61	00:11.04
Search Wikipedia	00:01.44	00:02.50
Open Google Maps	00:04.91	00:08.23
Enter Street View on Google Maps	00:03.89	00:04.70
Capture first screenshot with PicMonkey Extension	00:08.80	00:13.83
Save first edited screenshot with PicMonkey	00:05.01	00:07.08
Capture second screenshot with PicMonkey Extension	00:07.79	00:13.99
Save second edited screenshot with PicMonkey	00:05.32	00:06.96
View images in Google Gallery	00:04.46	00:06.75
Play video in Google Drive	00:02.83	00:05.26
Total	**01:03.00**	**01:36.72**

Figure 9: Median results for each task in our history project scenario, in minutes:seconds. Lower numbers are better.

Figures 10 and 11 detail the FPS results for the 25 screenshots for each scenario.

Learning anatomy in science class scenario – BioDigital Human		
	Intel processor-powered HP Chromebook 14 G1	NVIDIA Tegra K1 processor-based Acer Chromebook 13
Frame 1	52.7	30.0
Frame 2	54.0	34.4
Frame 3	53.0	30.0
Frame 4	57.0	30.0
Frame 5	56.0	30.0
Frame 6	52.0	30.5
Frame 7	54.0	30.0
Frame 8	60.0	30.0
Frame 9	54.0	32.5
Frame 10	52.0	30.0
Frame 11	58.0	30.0
Frame 12	58.0	30.0
Frame 13	53.0	32.9
Frame 14	56.0	29.5
Frame 15	59.0	30.0
Frame 16	54.0	30.0
Frame 17	53.0	29.5
Frame 18	56.0	29.5
Frame 19	59.0	37.4
Frame 20	52.0	30.0
Frame 21	52.0	30.0
Frame 22	59.0	30.0
Frame 23	55.0	30.5
Frame 24	51.0	30.0
Frame 25	58.0	30.0
Average	**55.1**	**30.7**

Figure 10: Frames per second for the 25 screenshots in our science classroom scenario. Higher numbers are better.

Creating videos for a history project scenario – Google Maps		
	Intel processor-powered HP Chromebook 14 G1	NVIDIA Tegra K1 processor-based Acer Chromebook 13
Frame 1	54.0	33.1
Frame 2	46.0	39.7
Frame 3	45.0	16.2
Frame 4	50.0	26.6
Frame 5	49.0	24.0
Frame 6	45.2	22.6
Frame 7	56.0	26.3
Frame 8	47.0	38.4
Frame 9	60.0	39.3
Frame 10	51.0	30.0
Frame 11	40.0	35.8
Frame 12	43.0	41.0
Frame 13	42.3	23.5
Frame 14	46.0	38.7
Frame 15	59.0	26.6
Frame 16	55.0	45.0
Frame 17	53.0	26.6
Frame 18	47.0	38.7
Frame 19	43.0	16.8
Frame 20	41.3	18.1
Frame 21	55.0	22.1
Frame 22	42.0	39.4
Frame 23	56.0	30.0
Frame 24	55.1	60.0
Frame 25	60.0	26.6
Average	49.6	31.4

Figure 11: Frames per second for the 25 screenshots in our history project scenario. Higher numbers are better.

ABOUT PRINCIPLED TECHNOLOGIES

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