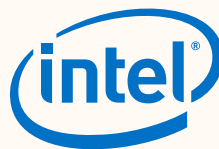


# *The Right Chromebook for K-12 Education*

How processor performance affects teaching and learning

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## *Table of Contents*

<b>Less Waiting, More Learning with Intel®-powered Chromebooks</b>	<b>3</b>
Choosing the Right Chromebook for Learning	3
Test Devices	4
Conclusion	4
The Value of Time Saved	5
Overall Test Results	6
<b>Classroom Test Scenarios and Outcomes</b>	<b>7</b>
Educator Professional Learning Scenario	7
Digital Storytelling	8
Middle School Classroom Scenario	9
Interdisciplinary Public Service Announcement Project	10
High School Classroom Scenario	11
Science Project on Modeling and Simulations	12
<b>Appendix</b>	<b>13</b>
A. Device Specifications	13
B. Test Results	14
C. Scenario Testing Details	17
D. Average U.S. Teacher Salary	22

## *Less Waiting, More Learning with Intel®-powered Chromebooks*

The need for affordable and sustainable technology solutions that improve learning outcomes and better engage students has led many U.S. educational institutions to implement widespread device adoptions. Based on CoSN's Annual Infrastructure report, 59% of high schools and 63% of middle schools report that 100% of their students have access to non-shared, or 1:1 devices.<sup>1</sup>

In order to equip students and teachers with the tools they need to be successful, many school districts have selected Chromebooks as their preferred student device. Recently, Google\* reported that in Q4 of 2018, 21% of all notebooks sold in the U.S. were Chromebooks and that last year alone, the number of monthly Chrome OS\* users who had Android\* apps enabled on their devices, grew by 250%.<sup>2</sup>

In the past, Chromebooks were only able to run Chrome web apps, G Suite for Education\* add-ons, and browser extensions, limiting their usability as compared to other devices and operating systems. With the addition of Android app support, Chromebooks are a much more powerful option for K-12 education. These apps can enhance student and educator experiences by adding new and practical uses for the Chromebook.<sup>3</sup> Due to the increased capability of Chromebooks that support Android apps and devices with more powerful configurations including faster processors and increased memory and storage, more and more schools are looking to refresh their deployments of both student and teacher devices with the latest generation of Chromebooks.

### Choosing the Right Chromebook for Learning

Selecting the right Chromebook for students and educators can be challenging given the ever-increasing number of devices and configuration options. In order to help educators separate the wheat from the chaff, Intel® commissioned Clarity Innovations to evaluate four commonly selected Chromebooks and test their effectiveness at completely common learning and professional development scenarios. As part of our testing, we selected typical applications used in K-12 such as G Suite for Education along with a variety of Android apps. We found that devices powered by Intel® technology allow educators and students to complete learning tasks using educational Android apps faster than devices with MediaTek\* or AMD\* processors.

1 CoSN 2018-2019 Annual Infrastructure Report

2 *What's new in Chrome OS? A faster, simpler, and more secure environment for Web and Android developers* retrieved from [Google Developers Blog](#)

3 *Android apps for Chromebooks: The essentials* retrieved from [Computerworld](#)

## Test Devices

We identified four Chromebooks from a variety of device manufacturers to test based on the three lesson scenarios we developed. Included below the image of each device is the manufacturer name and model number of the processor. Complete details on the device specifications are available in the Appendix.

Acer* Chromebook Spin 13	Dell* Chromebook 11 3100	Lenovo* 300e	HP* Chromebook 14
			
Intel® Core™ i5-8250U	Intel® Celeron® N4000	MediaTek* 8173C	AMD* A4-9120

## Conclusion

When it comes to teaching and learning, one of the most valuable resources in any classroom is time. During the adoption process, purchasing low cost devices may seem like a good deal; however, the hidden cost of lost learning time can have detrimental effects to both students and educators. Chromebooks with processors powered by Intel® technology save important teaching and learning time by reducing delays and allowing students and educators to spend less time waiting for the processor to keep up with a learning task.

However, when testing the processing time for using Android apps to complete more complex tasks like creating and exporting video projects and building and exporting 3D models and simulations, we discovered great differences in processor speed and learning time saved. The table below illustrates the total learning time saved over the four-year life of the device by using a Chromebook powered by an Intel® processor.



## The Value of Time Saved

Calculations below are based on middle and high school teachers employing similar learning scenarios as those outlined in this report in five (5) separate 45-minute classes per day at a minimum of twice (2) a week for 30 weeks (Difference\*5\*45\*2\*30). Total learning time saved is based on comparison with the slowest device. See Appendix D for additional details on average U.S. teacher salary and explanation of calculations.

	HP* Chromebook 14 AMD* A4-9120	Dell* Chromebook 11 3100 Intel® Celeron® N4000	Acer* Chromebook Spin 13 Intel® Core™ i5-8250U
Educator Professional Development Scenario	629.2 seconds	320.5 seconds	119.0 seconds
Total learning time saved (as compared to the AMD A4-9120-based device)		25.7 hours/year	42.4 hours/year
Over the 4-year life of the device		102.8 hours	170 hours
Value of time saved in a high-school		<b>\$ 3,034.65</b>	<b>\$ 5,018.40</b>
Middle School Scenario	241.9 seconds	145.7 seconds	114.2 seconds
Total learning time saved (as compared to the AMD A4-9120-based device)		8.0 hours/year	10.6 hours/year
Over the 4-year life of the device		32 hours	42.4 hours
Value of time saved		<b>\$ 944.64</b>	<b>\$ 1,251.64</b>
High School Scenario	243.6 seconds	207.7 seconds	128.1 seconds
Total learning time saved (as compared to the AMD A4-9120-based device)		3.0 hours/year	9.7 hours/year
Over the 4-year life of the device		12 hours	38.8 hours
Value of time saved		<b>\$ 354.24</b>	<b>\$ 1,145.37</b>

*Note: The above table does not include results for the Lenovo\* 300e device with a MediaTek\* 8173C processor in order to highlight the difference between the slowest device and the faster devices found in our testing.*

## Overall Test Results

The learning scenarios we developed and tested were created to realistically simulate what most students and educators experience when using technology in and out of the classroom. Most lessons require the use of a web browser for access to information and research, as well as simple collaborative authoring tools like those offered in G Suite for Education. As the complexity of the learning scenario tasks increased – such as through video editing or 3D object modeling – the value of the more powerful processors had a significant impact on the time it takes to complete a lesson.

Total time (in seconds) per learning scenario	HP* Chromebook 14 AMD* A4-9120	Lenovo* 300e MediaTek 8173C	Dell* Chromebook 11 3100 Intel® Celeron® N4000	Acer* Chromebook Spin 13 Intel® Core™ i5-8250U
Educator Professional Development Scenario	629.2 secs	481.2 secs	320.5 secs	119.0 secs
Middle School Scenario	241.9	214.6	145.7	114.2
High School Scenario	243.6	235.7	207.7	128.1



## *Educator Professional Learning Scenario*

The following sections outline typical K–12 learning scenarios that compare the classroom experience for educators or students using devices with the four featured processors. The learning scenarios include educator professional learning, middle school cross curricular mathematics and humanities, and high school science. Each scenario explains the educator or student tasks involved in the activity and then gives the outcomes and highlights of our test results, in addition to the functionality differences and the timed results for performance. For step-by-step test procedures and all timed-test results, see the Appendix.

### At a Glance

**Grade Level:** Classroom Educator

**Subject Area:** Professional Development

This scenario focuses on online educator professional development to enroll in an online course, collaborate with colleagues, and learn the process of video production in preparation for creating digital storytelling lessons with students.

#### Learning Skills Addressed

- Digital Communication and Collaboration
- Digital Content Creation
- Active Learning

#### Apps

- Google Chrome
- Adobe\* Photoshop\* Express
- G Suite for Education
- InShot\*

### Digital Storytelling

Aimee Sampson is a middle school social studies teacher who is using her spring break as an excuse to develop her digital filmmaking skills. She would like to institute rich, project-based learning involving digital storytelling in her classroom, so she takes a MOOC (Massive Open Online Course) on digital storytelling. Aimee is hoping to help her students develop short films for digital platforms.

Aimee opens the course in the Chrome web browser and logs in. She creates individual, new tabs for all of the course materials and discussion board. For this particular lesson, Aimee is exploring how to assemble all of the elements (text, images, narration, music, and video clips) to create the final version of her digital storytelling project. She uses the Chrome web browser to open Pixabay\* and complete searches for copyright free image assets to add to her title cards. Aimee downloads multiple images to her device and then opens Adobe Photoshop Express and uploads the images into the program where she can use image manipulation, such as text, shapes, and filters to create title cards.

Aimee is collaborating online with a colleague—an English teacher named Steve—via Google Docs. Aimee shares the Google doc link with Steve through an email. Using Google Docs’ chat and commenting features, the two compare tips and tricks for video production while capturing best practices as notes on the doc. Amy also inserts her title card images into the doc so Steve can give her feedback on which ones to use and what she might want to change or revise. She keeps Adobe Photoshop Express open so she can make edits to her title cards in real time. Once she has worked through Steve’s feedback, Aimee re-exports any images that she changed and saves them to her device.

Next, Aimee opens up InShot and begins to assemble her project. She creates a new video and imports all of her image and video assets into the program. Aimee then begins to edit the video in timeline mode. She wants to make her digital storytelling project unique, so she uses InShot’s features to add custom music to her video. Once she has her video edited, she saves and exports it to her device. In order to solicit feedback from Steve, Amy uploads her finished video file to Google Drive where she can share it with Steve so he will have access to view the video and offer feedback.

While the three slower processors tested in this scenario are found in typical student devices, the Intel® Core™ i5-based device is the type of notebook that most educators would prefer to have to future-proof the devices they use daily in their classrooms. The fastest processor, an Intel® Core™ i5-8250U, completed all the steps in this scenario 5.3-times faster than the slowest processor, and the Intel® Celeron® N4000 completed the same tasks 2-times faster than the slowest processor. The differences and effects of processor speeds can be seen in how quickly videos were created and exported using the InShot app.

On average, the Intel®  
Core™ i5-8250U device  
exported videos

**10.2x**

times faster than the  
AMD\* A4-9120-based  
device

Average time	AMD* A4-9120	MediaTek 8173C	Intel® Celeron® N4000	Intel® Core™ i5-8250U
Saving and exporting videos in InShot	224.0 secs	293.6 secs	69.2 secs	21.9 secs



## Middle School Classroom Scenario

### At a Glance

**Grade Level:** 6-8

**Subject Area:** Mathematics and Humanities

This scenario describes how two middle school teachers create a cross-curricular activity to help deepen learning, engagement and collaboration for their students. This project-based lesson helps students to understand the importance of individual skill sets and how they harmonize with larger goals, while creating an opportunity for contextualizing and connecting content knowledge: making students more likely to remember what they have learned.

#### Learning Skills Addressed

- Data Science
- Design Thinking
- Digital Communication and Collaboration
- Digital Content Creation

#### Apps

- G Suite for Education
- Fuse\*
- Wakelet\*
- Explain Everything\*
- Adobe Illustrator Draw\*
- RawGraphs\*

### Interdisciplinary Public Service Announcement Project

Middle school teachers Anthony Hayes and Gina Warren want to create a collaborative cross-curricular project across their various classes, Math and Humanities, respectively. They decide to involve data visualization as part of a creative branding PSA (Public Service Announcement) project.

Students work collaboratively in groups to create a campaign that raises awareness of a social issue, creates a call to action, and poses possible solutions. Before getting started, Anthony and Gina have their students use the Chrome web browser and the Fuse app to explore, analyze, and compare different types of data visualizations.

After getting a better idea of how data visualizations help people understand social issues, students re-search various aspects of their chosen social issue using websites and online databases, curating and collecting their findings using the Wakelet app. This visual content platform allows students to curate their online information, so it is easier to find and share with both Anthony and Gina, who are then able to give groups feedback in real-time.

To create data visualizations based on their findings, students are given the option to use one of two apps, Adobe Illustrator Draw or RawGraphs. These tools allow them to build assets that showcase specific statistics to help them raise awareness of their chosen social issue and also craft a compelling call to action. After creating at least one data visualization, students export their file(s) onto their devices.

Once the files have downloaded, they import them, as well as any other assets they've created and collected, into the Explain Everything app where they are able to create dynamic PSAs that raise awareness of their social issue and compel their audience to act through an inspirational call to action. Once they've finalized their projects, they export a high-quality version to their devices to be premiered for other students at their school's spring film festival.

The fastest processors, both powered by Intel® technology, completed all the steps in this scenario faster than the MediaTek and AMD processors. The Intel® Core™ i5-8250U processor was 2.1-times faster than the slowest device, the AMD\* A4-9120. While the Intel® Celeron® N4000 was 1.7-times faster than the AMD\* A4-9120. For example, the differences and effects of processor speeds can be seen in how quickly final project were created and exported using the Explain Everything app.

On average, the Intel®  
Core™ i5-8250U device  
created and exported  
projects

**2.9x**

times faster than the  
AMD A4-9120-based  
device

Average time	AMD* A4-9120	MediaTek* 8173C	Intel® Celeron® N4000	Intel® Core™ i5-8250U
Project creation and exporting in Explain Everything	144.3 secs	118.9 secs	78.7 secs	49.6 secs

## High School Classroom Scenario

### At a Glance

**Grade Level:** 9-12

**Subject Area:** Science

This scenario describes how a high school science teacher utilizes CAD and 3D modeling apps to create a project that gives her students the opportunity to use their 3D spatial reasoning skills to build and showcase a unique design.

#### Learning Skills Addressed

- Computational Thinking
- Simulation and Modeling
- Digital Content Creation
- Digital Communication and Collaboration

#### Apps

- SketchUp\* Viewer
- LiveBoard Interactive\*
- 3D Object Maker\*
- Padlet\*

### Science Project on Modeling and Simulations

Nicola Mansfeld wants to create a science curriculum that will engage her students with a sense of wonder and creativity. She decides to create a project that utilizes a 3D modeling application. Her students are tasked with taking an existing tool or object and inventing a new, more environmentally sound use for it.

Students begin by viewing historical 3D models in SketchUp Viewer—examining structural components and actively participating in discussions about how these structural systems function. Then, students use Chrome to access various websites to conduct research on the tools and simple machines they explored, including how and when they were invented and what time periods sparked new structures to be designed and built. While they are conducting their research, students use the LiveBoard Interactive app to curate their research, upload images and assets, and collaboratively reflect on each other's posts in real time.

Next, in teams, students work to brainstorm and plan their ideas for taking an existing tool or machine and creating a new, more environmentally sound use for it. Students document and organize their plans by creating schematic sketches and diagrams for their model. Once groups have settled on a design and finished their schematics, they utilize 3D Object Maker to design new inventions, noting particular parts of the tool or machine that are relevant for the new uses. When they are done creating their 3D models, they export them as obj files. After students export their files, they use Chrome to access Google Poly. This platform allows students to share and showcase their 3D models. Students export this model to their devices as a .gif file.

Nicola creates uses Padlet to create a wall that students use to share their gifs of their 3D designs. They upload the gif files to the wall via the Padlet app and add commentary on each other's posts to facilitate discussion. As an extension of the activity, some of Nicola's students have access to the school's after-school maker lab and use the obj files to turn their diagrams into physical, printed 3D models.

The fastest processor, the Intel® Core™ i5-8250U, completed all the steps in this scenario 1.9-times faster than the slowest processor from AMD\* A4-9120. For example, the differences and effects of processor speeds can be seen in how quickly devices were able to create and export 3D models in the 3D Object Maker app.

On average, the Intel® Core™ i5-8250U device exported 3D models

**4.1x**

times faster than the AMD\* A4-9120-based device

Average time	AMD* A4-9120	MediaTek* 8173C	Intel® Celeron® N4000	Intel® Core™ i5-8250U
Creating and exporting 3D models in 3D Object Maker	46.0 secs	32.5 secs	25.6 secs	11.1 secs



## Appendix

### A. Device Specifications

	Lenovo* 300e	HP* Chromebook 14	Dell* Chromebook 11 3100	Acer* Chromebook Spin 13
<b>Model Number</b>	81QC0006US	14-DB0020NR	NRCK2	CP713-1WN-53NF
<b>Operating System</b>	Chrome* OS version 75	Chrome* OS version 75	Chrome* OS version 75	Chrome* OS version 75
<b>Processor</b>	MediaTek* 8173C	AMD* A4-9120	Intel® Celeron® N4000	Intel® Core™ i5-8250U
<b>Processor Frequency</b>	2.10 GHz	1.83 GHz	2.6 GHz	1.60 GHz
<b>Storage</b>	32 GB	16 GB	32 GB	128 GB
<b>Memory</b>	4 GB	4 GB	4 GB	8 GB
<b>Battery Life</b>	Up to 10 hours	Up to 10 hours	More than 10 hours	Up to 10 hours
<b>Battery Capacity (Wh)</b>	42 Whr	47 Whr	42 Whr	46 Whr
<b>Display Size</b>	11.6"	14.1"	11.6"	13.5"
<b>Graphics</b>	NVIDIA* Imagination GX6250	Intel® HD Graphics 500	Intel® UHD Graphics 600	Intel® UHD Graphics 620
<b>Camera</b>	720p webcam	720p webcam	720p webcam	720p webcam
<b>Audio</b>	Stereo speakers	Stereo speakers	Stereo speakers	Stereo speakers
<b>Networking</b>	802.11ac	802.11ac	802.11ac	802.11ac
<b>USB</b>	1 x USB-C 1 x USB 3.0 HDMI	1 x USB-C 1 x USB 3.0 HDMI	2 x USB 3.1 2 x USB-C	1 x USB 3.0 2 x USB 3.1
<b>Bluetooth</b>	Bluetooth® 4.1	Bluetooth® 4.2	Bluetooth® 5.0	Bluetooth® 4.2
<b>Price at Time of Purchase</b>	\$ 292.00	\$ 229.00	\$ 355.00	\$ 899.00
<b>Weight</b>	3 lbs (1.35 Kg)	3.48 lbs (1.57 Kg)	2.85 lbs (1.29 Kg)	3.3 lbs (1.41 Kg)

## B. Test Results

Scenario 1	Lenovo* 300e MediaTek* 8173C				HP* Chromebook 14 AMD* A4-9120				Dell* Chromebook 11 3100 Intel® Celeron® N4000				Acer* Chromebook Spin 13 Intel® Core™ i5-8250U			
	1	2	3	Avg	1	2	3	Avg	1	2	3	Avg	1	2	3	Avg
<b>Google Chrome Browser Workload</b>																
Load Browser Tabs	118.9	103.1	100.1	<b>107.4</b>	352.9	270.8	244.2	<b>289.3</b>	174.9	103	198.6	<b>158.8</b>	44.3	43	24.3	<b>37.2</b>
Total for all subtasks	118.9	103.1	100.1	<b>107.4</b>	352.9	270.8	244.2	<b>289.3</b>	174.9	103	198.6	<b>158.8</b>	44.3	43	24.3	<b>37.2</b>
<b>Google Docs Collaboration</b>																
Create new Doc	7.8	9.7	9.5	<b>9.0</b>	12.1	10.8	7.7	<b>10.2</b>	8.3	9.2	7.8	<b>8.4</b>	4.6	4.1	3.9	<b>4.2</b>
Upload assets	2.1	2.7	3.7	<b>2.8</b>	2.7	3.6	2.8	<b>3.0</b>	3.3	2.9	3.6	<b>3.3</b>	1.1	1	1.3	<b>1.1</b>
Total for all subtasks	9.9	12.4	13.2	<b>11.8</b>	14.8	14.4	10.5	<b>13.2</b>	11.6	12.1	11.4	<b>11.7</b>	5.7	5.1	5.2	<b>5.3</b>
<b>Adobe Photoshop Express Image Editing</b>																
Open App	5.8	5.3	5.6	<b>5.6</b>	11.5	10.2	13.3	<b>11.7</b>	6.1	6.5	7.5	<b>6.7</b>	3.1	3.8	3.7	<b>3.5</b>
Save Image	12.2	12.2	9.3	<b>11.2</b>	15.5	21.2	24	<b>20.2</b>	9.2	12.1	8.7	<b>10.0</b>	3.5	3	4.1	<b>3.5</b>
Export Image	6.6	6.6	5.8	<b>6.3</b>	18	16.8	17	<b>17.3</b>	12.3	9.7	13	<b>11.7</b>	3.1	2.1	2.4	<b>2.5</b>
Total for all subtasks	24.6	24.1	20.7	<b>23.1</b>	45	48.2	54.3	<b>49.2</b>	27.6	28.3	29.2	<b>28.4</b>	9.7	8.9	10.2	<b>9.6</b>
<b>InShot Video Editing</b>																
Create Project	1.2	1.7	1.8	<b>1.6</b>	2.2	2.5	1.9	<b>2.2</b>	1.7	1.8	1.3	<b>1.6</b>	1.2	0.7	1.2	<b>1.0</b>
Save Project	298	294.3	283.9	<b>292.1</b>	213.1	221.9	230.5	<b>221.8</b>	71	61.2	70.5	<b>67.6</b>	22	17.5	23	<b>20.8</b>
Total for all subtasks	299.2	296	285.7	<b>293.6</b>	215.3	224.4	232.4	<b>224.0</b>	72.7	63	71.8	<b>69.2</b>	23.2	18.2	24.2	<b>21.9</b>
<b>Google Drive Asset Sharing</b>																
Upload Project	50.2	41.9	43.7	<b>45.3</b>	51	54.5	54.8	<b>53.4</b>	49.1	46.4	61.9	<b>52.5</b>	48	44.1	43	<b>45.0</b>
Total for all subtasks	50.2	41.9	43.7	<b>45.3</b>	51	54.5	54.8	<b>53.4</b>	49.1	46.4	61.9	<b>52.5</b>	48	44.1	43	<b>45.0</b>
<b>Scenario Total (seconds)</b>				<b>481.2</b>				<b>629.2</b>				<b>320.5</b>				<b>119.0</b>

For each scenario, we ran each test three (3) times and averaged out the results of the testing. All results below are expressed in seconds. For each task, we recorded a video of each device completing the step and then reviewed the video to determine the amount of time each one took.

Scenario 2	Lenovo* 300e MediaTek* 8173C				HP* Chromebook 14 AMD* A4-9120				Dell* Chromebook 11 3100 Intel® Celeron® N4000				Acer* Chromebook Spin 13 Intel® Core™ i5-8250U				
	Test Number	1	2	3	Avg	1	2	3	Avg	1	2	3	Avg	1	2	3	Avg
<b>Fuse: Viewing Data Visualizations</b>																	
Open App	9.1	7.3	7.5	<b>8.0</b>	27.3	15.4	13.2	<b>18.6</b>	6.9	6.9	10.7	<b>8.2</b>	5.6	4.5	4.3	<b>4.8</b>	
Search Query	2.9	3.3	2.9	<b>3.0</b>	11.2	4.2	3.8	<b>6.4</b>	7.2	2.2	3.7	<b>4.4</b>	3.9	2.2	1.9	<b>2.7</b>	
Total for all subtasks	12	10.6	10.4	<b>11.0</b>	38.5	19.6	17	<b>25.0</b>	14.1	9.1	14.4	<b>12.5</b>	9.5	6.7	6.2	<b>7.5</b>	
<b>Google Chrome: Viewing Data Visualizations</b>																	
DataViz: Bubble Chart	13.7	15.1	7.4	<b>12.1</b>	13.1	5.9	6.9	<b>8.6</b>	4.9	4.9	5.3	<b>5.0</b>	9.8	3	3.4	<b>5.4</b>	
DataViz: World Map	8	9	9.9	<b>9.0</b>	9.4	8.6	9.2	<b>9.1</b>	6.8	7.9	7.1	<b>7.3</b>	5.4	5.2	5.9	<b>5.5</b>	
DataViz: USA	44.2	44.2	46.9	<b>45.1</b>	38	36.8	36.9	<b>37.2</b>	34.7	34.2	34.3	<b>34.4</b>	33.5	33.3	33.4	<b>33.4</b>	
Total for all subtasks	65.9	68.3	64.2	<b>66.1</b>	60.5	51.3	53	<b>54.9</b>	41.5	42.1	41.4	<b>41.7</b>	48.7	41.5	42.7	<b>44.3</b>	
<b>Wakelet: Curating Research</b>																	
Open App	2.7	3.1	2.6	<b>2.8</b>	3.7	3.5	3.9	<b>3.7</b>	2.1	3.7	2.9	<b>2.9</b>	2.8	2.9	2.7	<b>2.8</b>	
Upload Asset	5.8	4.9	4.4	<b>5.0</b>	5.7	5.6	5.3	<b>5.5</b>	4.5	3.9	4.4	<b>4.3</b>	3.3	3.3	3	<b>3.2</b>	
Save Image	6.6	18.5	7.1	<b>10.7</b>	12	6.4	6.6	<b>8.3</b>	5.9	5.7	5.4	<b>5.7</b>	7.2	6.4	6.9	<b>6.8</b>	
Total for all subtasks	15.1	26.5	14.1	<b>18.6</b>	21.4	15.5	15.8	<b>17.6</b>	12.5	13.3	12.7	<b>12.8</b>	13.3	12.6	12.6	<b>12.8</b>	
<b>Explain Everything: Project Creation</b>																	
Open App	2.6	2.4	2.6	<b>2.5</b>	2.5	2.2	1.7	<b>2.1</b>	2.5	1.2	1.9	<b>1.9</b>	1.5	0.6	1.1	<b>1.1</b>	
Import Asset	18.4	19.1	16.3	<b>17.9</b>	15.4	17.6	17.6	<b>16.9</b>	14.5	15.9	16.6	<b>15.7</b>	13.9	32.6	6.9	<b>17.8</b>	
Export Video File	107	93	95.3	<b>98.4</b>	133.3	118.7	124	<b>125.3</b>	66.3	55.9	61.3	<b>61.2</b>	38.7	37.9	15.7	<b>30.8</b>	
Total for all subtasks	128	114.5	114.2	<b>118.9</b>	151.2	138.5	143.3	<b>144.3</b>	83.3	73	79.8	<b>78.7</b>	54.1	71.1	23.7	<b>49.6</b>	
<b>Scenario Total (seconds)</b>				<b>214.6</b>				<b>241.9</b>				<b>145.7</b>				<b>114.2</b>	

Scenario 3	Lenovo* 300e MediaTek* 8173C				HP* Chromebook 14 AMD* A4-9120				Dell* Chromebook 11 3100 Intel® Celeron® N4000				Acer* Chromebook Spin 13 Intel® Core™ i5-8250U			
	1	2	3	Avg	1	2	3	Avg	1	2	3	Avg	1	2	3	Avg
<b>SketchUp: Viewing 3D models</b>																
Download 3D model	17.9	18.7	18.8	<b>18.5</b>	5.5	4.5	3.7	<b>4.6</b>	2.7	2.7	2.4	<b>2.6</b>	18.5	18.2	14.1	<b>16.9</b>
Open 3D model	6.6	7.7	8.1	<b>7.5</b>	20.2	8.9	8.5	<b>12.5</b>	8.4	6.5	6.8	<b>7.2</b>	3.4	3.7	3.5	<b>3.5</b>
Total for all subtasks	24.5	26.4	26.9	<b>25.9</b>	25.7	13.4	12.2	<b>17.1</b>	11.1	9.2	9.2	<b>9.8</b>	21.9	21.9	17.6	<b>20.5</b>
<b>3D Object Maker: Creating 3D models</b>																
Open a .obj file	19.1	17.9	24.5	<b>20.5</b>	36.6	23.4	23.8	<b>27.9</b>	13.7	13.6	14.9	<b>14.1</b>	7.5	5.6	5.4	<b>6.2</b>
Save as .stl file	12.6	12.4	11.1	<b>12.0</b>	20	17.8	16.4	<b>18.1</b>	11.1	12.3	11.2	<b>11.5</b>	4.4	5.5	5	<b>5.0</b>
Total for all subtasks	31.7	30.3	35.6	<b>32.5</b>	56.6	41.2	40.2	<b>46.0</b>	24.8	25.9	26.1	<b>25.6</b>	11.9	11.1	10.4	<b>11.1</b>
<b>Google Poly: Preparing 3D objects for sharing</b>																
Upload 3D object file	38.1	30.8	29.8	<b>32.9</b>	29.8	32.3	33	<b>31.7</b>	27.5	31.5	32.7	<b>30.6</b>	30.6	30.8	25	<b>28.8</b>
Publish 3D object file	37.1	19.9	38.4	<b>31.8</b>	36.5	36.2	22.8	<b>31.8</b>	24.3	36.3	35.5	<b>32.0</b>	15.7	28.5	36.1	<b>26.8</b>
Create GIF	92	95.1	105.2	<b>97.4</b>	103.3	105.9	107.6	<b>105.6</b>	89.6	95.7	104.9	<b>96.7</b>	22.4	35.7	37.5	<b>31.9</b>
Total for all subtasks	167.2	145.8	173.4	<b>162.1</b>	169.6	174.4	163.4	<b>169.1</b>	141.4	163.5	173.1	<b>159.3</b>	68.7	95	98.6	<b>87.4</b>
<b>Padlet: Sharing GIF</b>																
Share GIF	12.5	14.8	18.1	<b>15.1</b>	11.6	11.7	10.9	<b>11.4</b>	9.8	15.6	13.3	<b>12.9</b>	8.9	10.4	7.9	<b>9.1</b>
Total for all subtasks	12.5	14.8	18.1	<b>15.1</b>	11.6	11.7	10.9	<b>11.4</b>	9.8	15.6	13.3	<b>12.9</b>	8.9	10.4	7.9	<b>9.1</b>
<b>Scenario Total</b>				<b>235.7</b>				<b>243.6</b>				<b>207.7</b>				<b>128.1</b>



## C. Scenario Testing Details

### Lesson Scenario 1

#### *Simulating the browser workload*

##### Setting the browser

1. Open Chrome.
2. At the top right, click More then Settings.
3. Under "On startup," select Open a specific page or set of pages.
4. Add the following web addresses:
  - reddit.com/r/pics
  - instagram.com/intel
  - simple.wikipedia.org
  - mail.google.com
  - slack.com
  - drive.google.com
  - docs.google.com
  - youtube.com/feed/music
  - sheets.google.com
  - twitter.com
  - facebook.com
5. Restart Chromebook and ensure the pages load as expected.

##### Testing load time

1. Simultaneously start the timer and login to Chromebook (which automatically opens Chrome browser).
2. When Chrome tabs have fully loaded, stop the timer.

#### *Collaborating via Google Docs*

##### Create a new Google Doc

1. Open the Chrome tab containing Google Docs
2. Simultaneously start timer and choose the option to create a new Google Doc

3. When the new Google Doc has fully loaded, stop the timer.
4. Upload assets to a Google Doc:
5. Choose Insert > Image > Upload from computer
6. Locate and select 4 MB jpeg file
7. Start timer and press Open
8. Stop timer when image has fully loaded

#### *Creating Title Cards with Adobe Photoshop Express*

##### Opening app

1. Simultaneously start timer and open Adobe Photoshop Express
2. Stop Timer once Adobe Photoshop Express fully loads

##### Image editing

1. From the Photo browser, choose 4MB jpeg file
2. Apply the following edits to the image:
  - Filter: Duo Tone Teal
  - Beta filter: Light Leak L3
  - Radial Blur
  - Text: "Strong & Fierce"
  - Enhance
  - Press the Next button
  - Keep the Original image dimensions
  - Set the JPEG quality to 100%

##### Save the edited image

1. Simultaneously start the timer and press Save to Gallery
2. Once the file has saved, stop the timer.

### Export asset to InShot

1. Choose Others
2. Simultaneously Start timer and select InShot
3. Once the image has fully exported to InShot, stop the timer

### *Video Creation with InShot*

#### Creating the project

1. Choose Video
2. Choose New
3. Choose the ALL tab to display assets
4. Select both a 25MB video (mp4) and a 14 MB image (jpg)
5. Simultaneously start the timer and press the Checkmark to confirm selection
6. Once the assets have fully loaded into the project, stop the timer

#### Editing the project

1. Choose Filter > Vintage > Checkmarks > Apply to All
2. Choose Music > InShot Classic > Journey 1 > USE > Checkmark

### Saving the project

1. Choose SAVE
2. Simultaneously start timer and choose 1080p (~45MB)
3. Once the video has saved, stop the timer

### Google Drive

1. Open Google Drive app
2. Choose the + button and choose Upload
3. Locate and Select the InShot video project
4. Simultaneously start the timer and press Open
5. When the file has fully loaded, stop the timer

## Lesson Scenario 2

### *View Data Visualizations with Fuze Opening App:*

#### Opening app

1. Simultaneously start timer and open Fuse
2. Stop Timer once Fuse fully loads
3. Run a search query:
4. Select the tab titled People
5. Press Search Icon
6. Set the following search options:
  - Demog. Stat. : Population Total
  - Samples Type: Food Consumption
  - Category Type: Chronic Statistics
  - Consumers only: All Subjects
  - Exposure Level: 1
  - Exposure Hierarchy: 1st ten items
7. Simultaneously start the timer and press Search
8. When the visualization fully loads, stop the timer.

#### View data visualizations with Chrome

1. Simultaneously start timer and refresh the following tab:
  - <https://vizabi.org/examples/bubble-chart.html>
2. When the page fully loads stop the timer.
3. Simultaneously start timer and refresh the following tab:
  - [https://www.inetsoft.com/evaluate/bi\\_visualization\\_gallery/dashboard.jsp?dbldx=5](https://www.inetsoft.com/evaluate/bi_visualization_gallery/dashboard.jsp?dbldx=5)
4. When the page fully loads stop the timer.
5. Simultaneously start timer and press Play on the following page:
  - [http://www.openheatmap.com/examples/us\\_unemployment\\_county/](http://www.openheatmap.com/examples/us_unemployment_county/)
6. When the chart finishes playing, stop the timer.

### *Curating Research on Wakelet*

#### Opening app

1. Simultaneously start timer and open Wakelet
2. Stop Timer once Wakelet fully loads

#### Upload assets

1. Open a collection
2. Choose Add item
3. Choose a new image
4. Choose a 25 MB image file
5. Simultaneously start the timer and click "select"
6. When the image has fully uploaded, stop the timer.

#### Saving an image

1. Simultaneously start the timer and press Save
2. When the image displays in collection stop the timer.

### *Project Creation in Explain Everything*

#### Opening app

1. Simultaneously start timer and open
2. Stop Timer once Fuse fully loads
3. Import 25 MB image
4. Choose New Project from File
5. Simultaneously start the timer and select a 25 MB image from file system
6. When the file has fully uploaded, stop the timer
7. Press Done

### Recording a video

1. Press the Insert an Object button
2. Choose New Video
3. Record 60 seconds of video
4. Export Video
5. Press the Export Button
6. Simultaneously start the timer and choose the select Export option
7. Once the exporting is complete, stop the timer

## Lesson Scenario 3

### SketchUp

#### Download 3D model

1. Open SketchUp App
2. Touch Cloud icon > 3D Warehouse
3. Locate a 9 MB 3D Warehouse project
4. Simultaneously start the timer and press Download
5. When the file fully downloads, stop the timer

#### Open 3D projects

1. Simultaneously start timer and press the Open button
2. When the file fully loads, stop the timer

### 3D Object Maker

#### Open a obj file

1. Press the Open icon
2. Locate and select 33 MB .obj file
3. Simultaneously start timer and Open .obj file
4. Stop Timer once .obj file fully loads
5. Save as .stl file
6. Simultaneously start timer and the press the Download as STL button
7. Once the file has fully downloaded, stop the timer

### Google Poly

#### Upload a 3D file

1. Navigate to Google Poly (poly.google.com)
2. Press the Upload icon

3. From file finder, locate and select a 9 MB .obj file
4. Simultaneously start timer and press Upload
5. When the object fully uploads, stop the timer.

#### Publish a 3D file

1. Enter project description
2. Simultaneously start timer and press Publish
3. Once the file fully publishes, stop the timer

#### Create a GIF

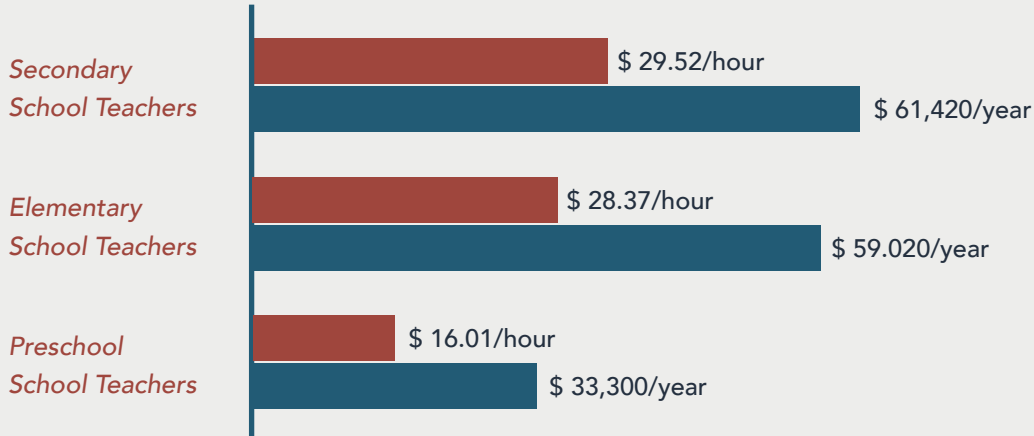
1. Press the Create GIF button
2. Choose 16:9 Aspect and 1x Speed
3. Simultaneously start timer and press Download
4. Once the GIF has fully downloaded, stop the timer

### Padlet

#### Upload GIF

1. Open Padlet app
2. Press the Make A Padlet option
3. Choose A Wall-type Padlet
4. Press the + button
5. Press the Upload icon
6. Select a 3.5 MB GIF file
7. Simultaneously start the timer and press Open
8. Once the GIF has fully loaded to Padlet, stop the timer

### D. Average U.S. Teacher Salary



Based on 2018 data collected by the U.S. Bureau of Labor and Statistics as reported by the [Houston Chronicle](#).

### Value of Time Saved Calculations

	Seconds saved per class as compared to the slowest device	Seconds saved per day (assumes 5 classes per day)	Seconds saved per week (assumes minimum 2 times per week)	Seconds saved per year (assumes min 30 weeks per school year)	Expressed as hours	Hours over the 4-year lifespan of the device
Educator Professional Development scenario using the Dell* Chromebook 11 3100 Intel® Celeron® N4000	308.7 seconds saved per class	1,543.5 seconds saved per day	3,087 seconds saved per week	92,610 seconds saved per school year	25.7 hours saved per school year	102.8 hours saved over the 4-year life of the device

The analysis in this document was performed by Clarity Innovations, Inc. and commissioned by Intel.

For more complete information about performance and benchmark results, visit [www.intel.com/benchmarks](http://www.intel.com/benchmarks).

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