K-12 BLUEPRINT

The Right Windows Device for Virtual Learning	Commissioned by Intel®
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The Right Windows Device for Virtual Learning

How device performance impacts teaching, learning, and total cost of ownership

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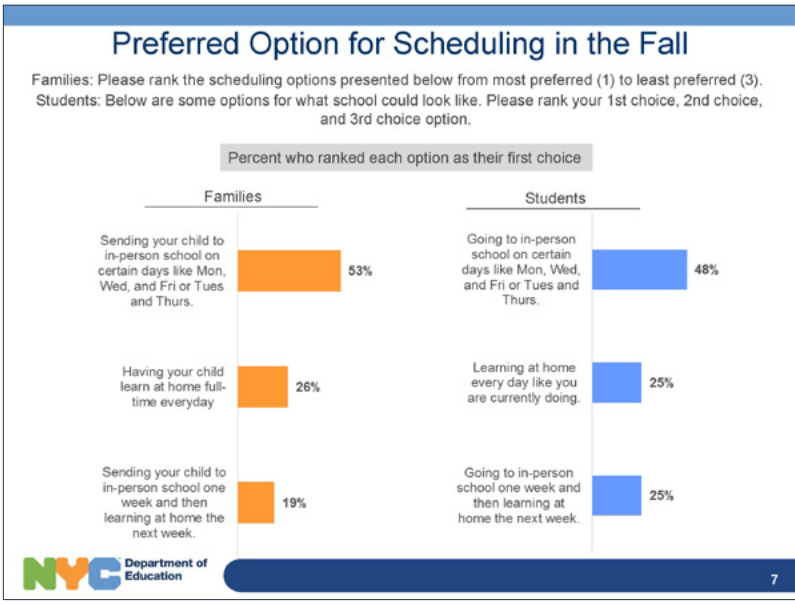
Table of Contents

Executive Summary

Over the past few years, the use of laptops and other educational technologies by teachers and students has exploded into mainstream adoption with 74% of U.S. schools reporting at least 1 device per student.[1] Never has access to the internet been more important than now, during the COVID-19 pandemic. While technology implementation models vary both at state and district levels, the goal during this time has remained the same: *to use technology and other tools to better engage and connect students and improve learning outcomes.* To support virtual teaching and learning, schools must be even more aware of their students' device needs, instructional goals, and the specific curricular demands on the technology.

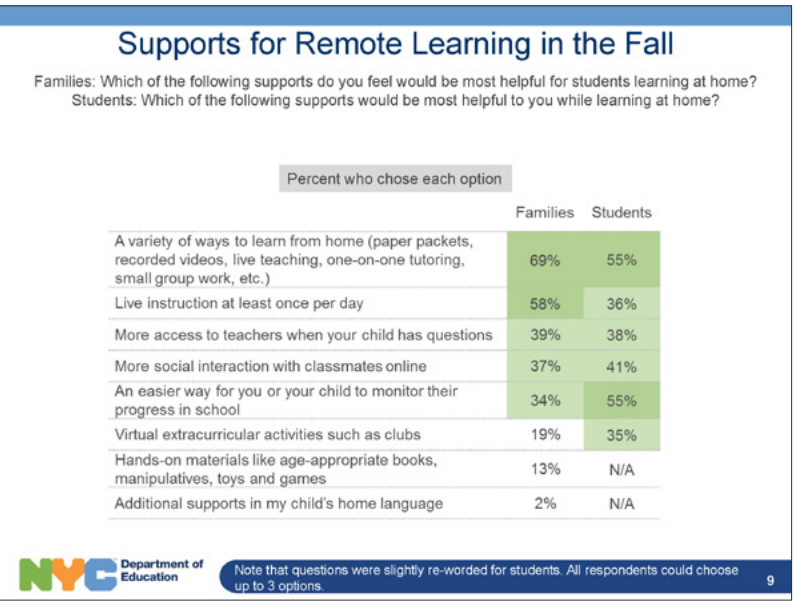
States and school districts are busy planning for what teaching and learning will look like in the upcoming school year, posing questions about how they can best support educators and students in meeting instructional goals and how to provide reliable technology to make remote learning a connected and engaging experience. Some districts, like the New York City Department of Education, surveyed families and students to gain more insight on specific needs, concerns, and feelings around things such as health and safety precautions and scheduling options.[2] The results show a wide variety of needs, concerns, and strategies that schools are exploring.



Specifically, there are many scenarios for virtual learning being considered for how teaching and learning might look during the upcoming school year, including:

- **Brick-to-Click:** a school district resumes traditional in-person classes with the flexibility to quickly pivot to distance education in the event of a COVID-19 outbreak;
- **Click-to-Brick:** a school district begins with online learning and resumes in-person classes when it is safe to do so;
- **Blended Learning:** a school district uses a combination of learning that takes place in-person and online both synchronously and asynchronously; and,
- **Online Learning:** a district uses a system-based approach to move all learning experiences and services online.[3]

[1] *Source:* CoSN 2018-19 Annual Infrastructure Survey Report
[2] *Source:* NYC Department of Education Fall 2020 Return to School Survey
[3] *Source:* Pandemic Planning for Distance Learning: Scenarios and Considerations from New America



Some districts, including NYC Department of Education, have furthered these types of scenarios into specific scheduling choices available to schools and families. These include flexibility for student groups who choose to learn primarily in-person, such as alternating days (e.g., every other day from Tuesday - Friday, or two consecutive days for groups, some on Tuesdays and Wednesdays and others on Thursdays and Fridays), or fully online learning experiences for families who do not wish for their children to return to school buildings.[4]

This paper explores the effects of processor speed on productivity and effectiveness of student devices to help provide insight and advice into answering questions around how schools and districts can best support educators and students in meeting instructional goals and how to provide reliable technology to make remote learning a connected and engaging experience.

During the Spring of 2020, the K-12 education team at Intel® hired Clarity Innovations to research and develop this report. We began by creating a set of remote learning scenarios for 3 grades - 7th, 9th, and 11th.

Our goal was to author scenarios which reflect typical instructional practices and student experiences for remote teaching and learning. Moreover, we wanted to make sure these experiences captured the sort of learning skills and capabilities necessary to prepare students to compete in the global workforce. These complex scenarios focus on higher order thinking skills on topics such as social and emotional learning (SEL) and game-based learning, computer programming and data collection, and publication authoring and design using augmented reality (AR).

> “ This paper explores the effects of processor speed on productivity and effectiveness of student devices ”

Once the learning scenarios were drafted, we identified two devices running Microsoft's* Windows* 10 operating system, one with an Intel® Celeron® processor and one with a 10th Generation Intel® Core™ i3 processor. In addition, we created step-by-step testing procedures for each scenario. Complete details on the devices, testing steps, and results can be found in the Appendix.

[4] *Source:* NYC Department of Education Return to School 2020: School Schedules

	
Intel® Core™ i3-based device	**Intel® Pentium® Silver-based device**
$ 598*	$ 569*

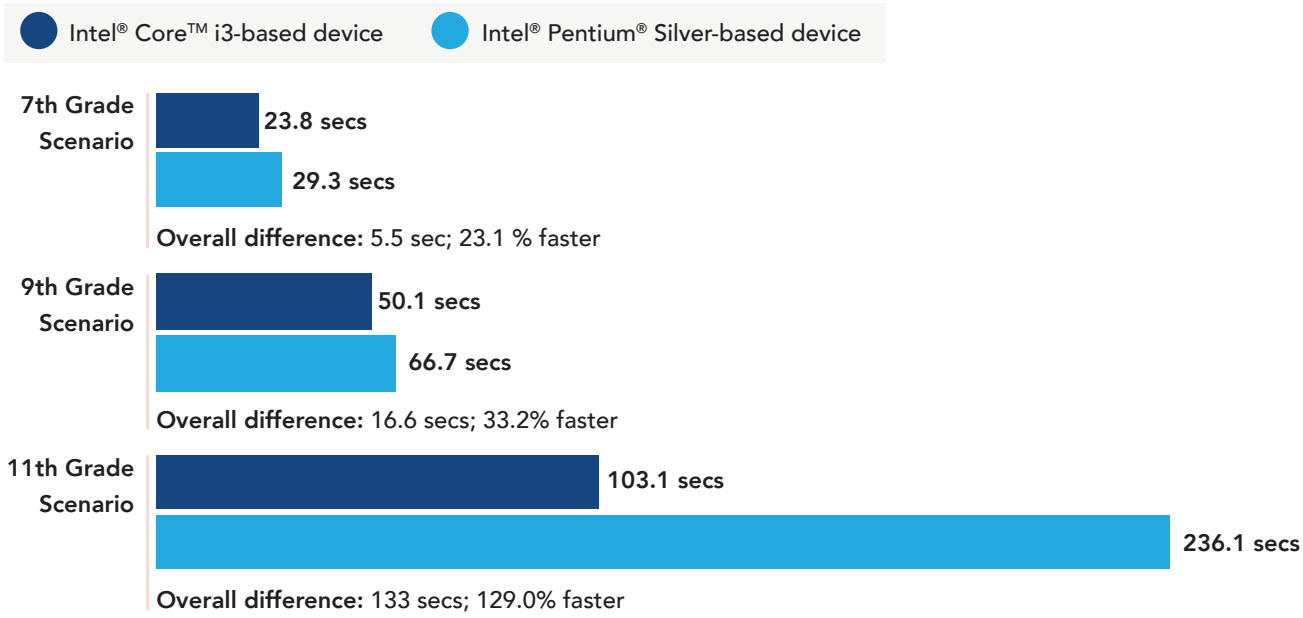
Table 1: Devices tested for this report
*Retail price at the time of purchase and testing

Choosing the Right Device for Remote Learning

In determining which devices to test, we recognize that schools have to be attuned to many factors including cost, durability, manageability (especially in a remote learning setting), and integration into their existing infrastructure. Keeping those considerations in mind, we identified two Windows*-based devices: an Intel® Pentium® Silver-based device and an Intel® Core™ i3-based device, as ones which are commonly used in K-12 education.[5]

While many of the device specifications were similar (e.g., both have HD webcams, similar storage and memory, and a variety of USB ports), the key criteria we wanted to test is how differences in processor speed impact teaching and learning in a remote setting.

[5] *Complete details on device specifications and configuration are available in* Appendix A.



Multitasking While Connected

The learning scenarios we developed and tested were created to realistically simulate what most students experience when using technology for remote learning. That is, most lessons require the use of the internet for connecting to others, collaborating on work with peers, and creating content using web-based apps as well as some stand-alone applications and programs. In our testing, we discovered compelling data around the effects processor speed has on the ability to multitask while connected. For instance, the Windows* 10 device with a more powerful 10th Generation Intel® Core™ i3 processor was able to complete tasks, such as photo and video editing and manipulation while being connected to a video conferencing call and brainstorming collaboratively using a whiteboard application, 129% faster the device with the Intel® Celeron® processor.

Increase Learning Time with Faster Performing Devices

For the three remote learning scenarios we developed, the overall results demonstrate the effect of a more powerful processor across grade levels and learning experiences. The scenarios themselves represent typical examples of remote teaching and learning: from game-based learning with Minecraft: Education Edition* and computer programming and data streaming using Micro:bit* and Makecode*, to digital content creation using photo and video software and augmented reality. Based on raw times averaged across a variety of tasks, the device with a 10th Generation Intel® Core™ i3 processor routinely completed the work two to three times faster than its counterpart.[6]

[6] *See Appendix B for test results.*

Virtual Learning Test Scenarios and Results

The following sections outline typical K–12 virtual learning scenarios that compare the learning experience for students using the two featured devices. The learning scenarios include: 7th grade Language Arts, 9th grade Computer Science, and 11th grade Journalism and Yearbook. Each scenario explains the student tasks involved 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 Appendix C.

Lesson Scenario 1

Practicing Mindfulness and SEL with Minecraft: Education Edition*

At a Glance

Grade Level: 7th grade

Subject Area: Language Arts

Class: English 7

A 7th grade Language Arts teacher helps her students foster social and emotional learning (SEL) through mindfulness practices. Students began by joining a morning check-in meeting with their teacher using Microsoft* Teams*. Students then launch The Mindful Knight world file in Minecraft: Education Edition* and work through four quests that help them learn more about mindfulness and social and emotional skills. While in-world, students use Microsoft* Immersive Reader to connect with texts, and built-in tools such as the camera and the book and quill to help them document their learning. Students end their learning experience using Windows* Gamebar* and Flipgrid* to create a screencast reflection.

Learning Skills Addressed

- Social and Emotional Learning
- Digital Content Creation
- Digital Communication and Collaboration

Applications

- Microsoft Teams*
- GoNoodle*
- Minecraft: Education Edition*
- Immersive Reader*
- Windows* Gamebar*
- Flipgrid*
- Microsoft Edge* web browser

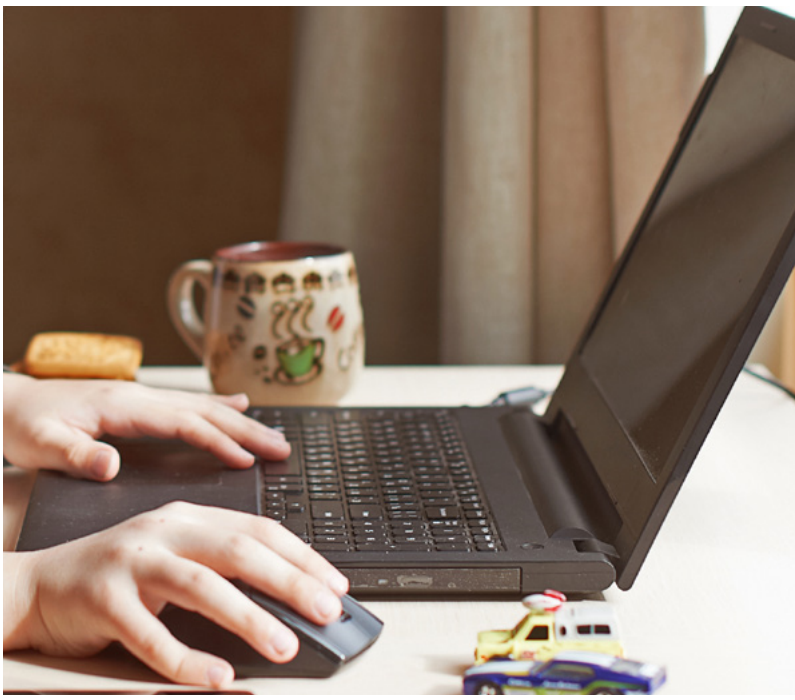
Marylin Barnes, a 7th grade Language Arts teacher, is excited to intentionally help her students foster social and emotional learning (SEL) skills. While students are working on honing their reflective writing skills, she hopes to encourage them to learn and engage in methods and strategies for practicing mindfulness during remote learning.

Marylin begins the remote learning day by inviting students to join a morning check-in meeting hosted on Microsoft Teams*. Students load the Teams* app on their devices and use the link on their calendar invitation to join the check-in. While on Teams*, Marylin streams a mindfulness exercise from GoNoodle* to help students practice breathing routines. She encourages students to do the breathing and movement activities in their remote workspaces while the video is streaming. After practicing mindfulness, students take turns sharing reflections of how the activity helps them focus for their day ahead.

After explaining to students that they will become medieval knights, going on four quests to learn more mindfulness strategies, Marylin shares a link to a Minecraft: Education Edition* world file with the class. She encourages them to consider what they've learned about reflective writing to help them capture their thoughts along the way.

Students download The Mindful Knight world file on their devices. Next, they open Minecraft: Education Edition* and import the Mindful Knight world. Students work through four quests that help them learn more about mindfulness and social and emotional skills. While in-world, students use the accessibility tool, Immersive Reader*, to connect with texts both visually and through audio. Built-in tools, such as the camera and the book and quill, help students document their learning. After capturing their reflections using these tools, students download their portfolios and share these with Marylin through Microsoft Teams*.

To end the learning experience, students use the Windows* Gamebar* to record their screen as they demonstrate what they've explored during their quests. These videos are then uploaded to a Flipgrid* topic that Marylin shares with students. Once recorded and shared on the grid, students are able to react and comment on each others' recordings, seeing how everyone engaged in mindfulness practices.



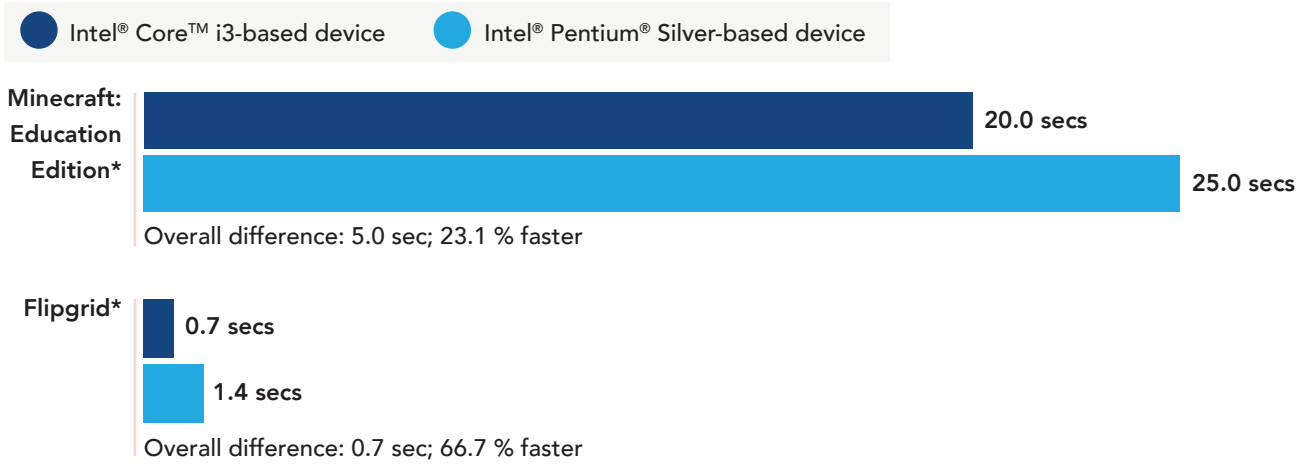
	Intel® Pentium™ Silver	Intel® Core® i3
Launching and generating Mindful Knight world	19.7 secs	14.6 sec

Table 4: Notable test results from the 7th grade remote learning scenario.

Test Results: Highlights

For this learning scenario, the fastest device, the Intel® Core™ i3-based device, completed all the steps on average 5.5 seconds faster than the Intel® Pentium® silver-based device. At 23.1% faster processing speed, the Intel® Core™ i3-based device offers students a more consistent and seamless learning experience when engaging in game-based learning and video conferencing.

The effects of processor speed on this remote learning scenario can be seen in how fast the devices were able to launch a Minecraft: Education Edition* world file in the application to begin engaging in in-world game play. The Intel® Core™ i3-based device performed 5.2 seconds faster or 35.5% faster than the Intel® Pentium® Silver-based device.



Lesson Scenario 2

Programming Micro:bit* for Data Collection

At a Glance

Grade Level: 9th grade

Subject Area: CTE

Class: Introduction to Computers and Programming

As the culminating activity for their course Introduction to Computers and Programming, computer science students use Micro:bit* and Makecode* to design and program something they can use during virtual learning to collect data. Using Micro:bit's* sensors (accelerometer, compass, light, or thermometer), students use javascript to program devices that can measure conditions, collect data, and stream that data to a Microsoft Excel* spreadsheet for analysis. To showcase their projects, students participate in a virtual gallery walk using Zoom* screen sharing and their OneNote* class notebook to compile feedback. These gallery walks are recorded and shared with their teacher using OneDrive*.

Learning Skills Addressed

- Computational Thinking
- Data Analysis
- Digital Content Creation
- Digital Communication and Collaboration

Applications

- Makecode*
- Micro:bit*
- Data Streamer* (extension for Microsoft Excel)
- Microsoft Excel*
- Zoom*
- Microsoft OneNote Class Notebook*
- Microsoft OneDrive*

Kamil Harrison, Introduction to Computer Science teacher, is excited to challenge his 9th grade students with an engaging culminating project. While learning remotely, Kamil's students have worked on their block coding and Javascript skills and are ready to problem solve using creativity and programming.

In addition to their Windows* devices, students use Micro:bit* to design and program something they can use during remote learning to collect data. Designs include things like step counters, simple games, alarms, weather trackers, headlamps and headlights, and thermostats. Students start by connecting a Micro:bit* to their devices. After connecting their Micro:bit*, students are ready to begin!

They open Makecode* and load a sample program as their starting point. Using the Makecode* application and Micro:bit's* accelerometer, compass, light, or thermometer sensors, Kamil's students switch from block coding to Javascript to program devices that can measure conditions and collect data. The collected data will be streamed to a Microsoft Excel* spreadsheet for analysis. Once students are finished writing their programs, they flash the Micro:bit* with their hex file, or download the hex file onto their devices and move it to the Micro:bit* folder.

After testing their creations, students open Microsoft Excel* and create a new spreadsheet that will capture their data and analysis. Using Data Streamer*, a Microsoft Excel* extension, students are able to connect their Micro:bit* and then use it to collect and stream data to a spreadsheet where it populates in real time. They analyze and synthesize the reported data using Microsoft Excel*'s tools to create graphs to help visualize their findings.

To showcase their projects, students participate in a virtual gallery walk using Zoom*. They open the application and use the link on their calendars to join the meeting. The student host hits record once everyone has joined the meeting and the first person begins screen sharing to explain their program and the data they collected. Using their OneNote* class notebook, students are able to compile feedback for each other in real time. After the last member of the group has shared, the host student stops the recording and downloads the mp4 file to their device. These gallery walk recordings and each students' hex file are uploaded to OneDrive* and shared with Kamil in a project folder.

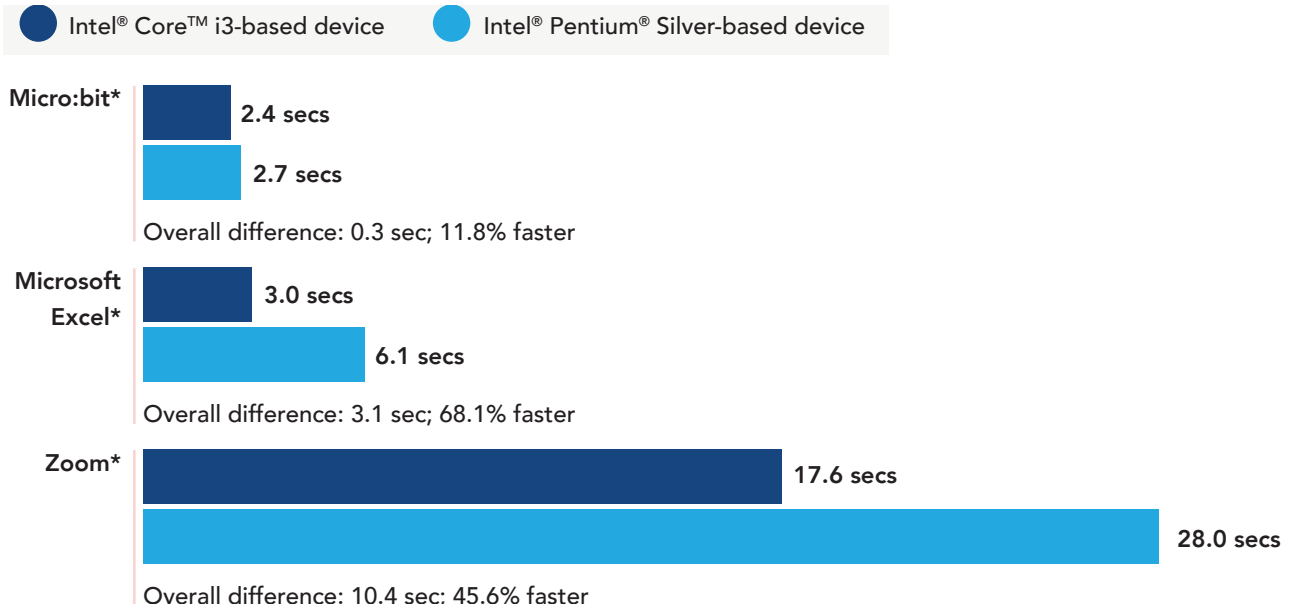
Test Results: Highlights

For this learning scenario, the fastest device, the Intel® Core™ i3-based device, completed all the steps on average 16.6 seconds faster than the Intel® Pentium® Silver-based device. At 33.2% faster processing speed, the Intel® Core® i3-based device offers students a more seamless learning experience when programming devices to collect and stream data and connecting with others to showcase their work using video conferencing.

The effects of processor speed on this remote learning scenario can be seen in how fast the devices were able to load Microsoft Excel* and connect a Micro:bit* device and when using Zoom* to both join video calls and download recorded video files. When loading Microsoft Excel* and connecting the Micro:bit* to the application, the Intel® Core™ i3-based device performed 3 seconds faster, or 100% faster than the Intel® Pentium® Silver-based device. Likewise, when using Zoom* to both join a video call and download a recorded video call, the Intel® Core™ i3-based device performed 10.4 seconds faster overall, or 59.4% faster than the Intel® Pentium® Silver-based device.

	Intel® Pentium® Silver	Intel® Core™ i3
Connecting Micro:bit* to Microsoft Excel*	6.2 sec	3.0 sec
Using Zoom*	28.0 sec	17.6 sec

Table 5: Notable test results from the 9th grade remote learning scenario.



Lesson Scenario 3

Next Level Yearbook Design with Augmented Reality

At a Glance

Grade Level: 11th grade

Subject Area: Digital Publishing

Class: Journalism and Yearbook

Virtual learning poses new challenges for the current yearbook staff, but with the right tools creating a dynamic yearbook is both fun and exciting. Student cohorts tackle brainstorming, planning, and designing their assigned yearbook sections collaboratively, in real-time using Microsoft Teams* and Microsoft Whiteboard*. Using Adobe* products such as Photoshop* and Premiere*, students manipulate, edit, and perfect the media before compiling it on yearbook pages in Adobe InDesign*. To take their yearbook to the next level and promote connectedness during remote learning, students amplify pages of the yearbook with augmented reality (AR) content such as video overlays that play or buttons that become clickable when pages of the yearbook are scanned with a phone.

Learning Skills Addressed

- Design
- Digital Content Creation
- Digital Communication and Collaboration

Applications

- Microsoft Teams*
- Microsoft Whiteboard*
- Adobe Photoshop*
- Adobe Premiere*
- Adobe InDesign*
- ROAR*

Remote learning poses new challenges for Julia Hernanz's current yearbook staff, but with the right tools creating a dynamic yearbook is a breeze. Julia and her students work hard to overcome constraints that remote learning places on the collaborative physical environment they're used to working in. Student cohorts work together to tackle sections and pages of the yearbook to meet their deadlines with their publisher. This year, to promote connectedness, the student staff decides to amplify some of the yearbook's pages with built in augmented reality (AR) experiences.

Student cohorts begin their work by opening the Microsoft Teams* app and joining a video call. Simultaneously, students open the Microsoft Whiteboard* app where they are met with an infinite canvas to brainstorm, plan, and design their assigned sections and pages, including which ones will include AR experiences. These two tools allow students to talk and record their ideas visually, in real time, and capture their thinking. Afterwards students upload their saved whiteboards to a project folder in Microsoft OneDrive* that is shared with Julia.

While working collaboratively, students use Adobe* applications such as Photoshop* and Premiere* to manipulate, edit, and perfect the media before compiling it into yearbook pages using Adobe InDesign*. Students crop photos, add filters, and apply advanced level editing to make sure each image captures the moment. In addition, many of the AR experiences will include video footage that students have submitted to the yearbook staff while learning remotely away from the school building. Using Adobe Premiere*, students are able to create clips, compress

large videos for a mobile format, and change the aspect ratio.

To take their yearbook to the next level, students create living moments on pages of the yearbook with AR content. Using ROAR*, students build AR experiences such as video overlays that play or buttons that become clickable when pages of the yearbook are scanned with a phone or mobile device. Now instead of just seeing static images of the band's first place win at the state competition, students can scan an image unlocking AR content that displays a video of one of the performances.

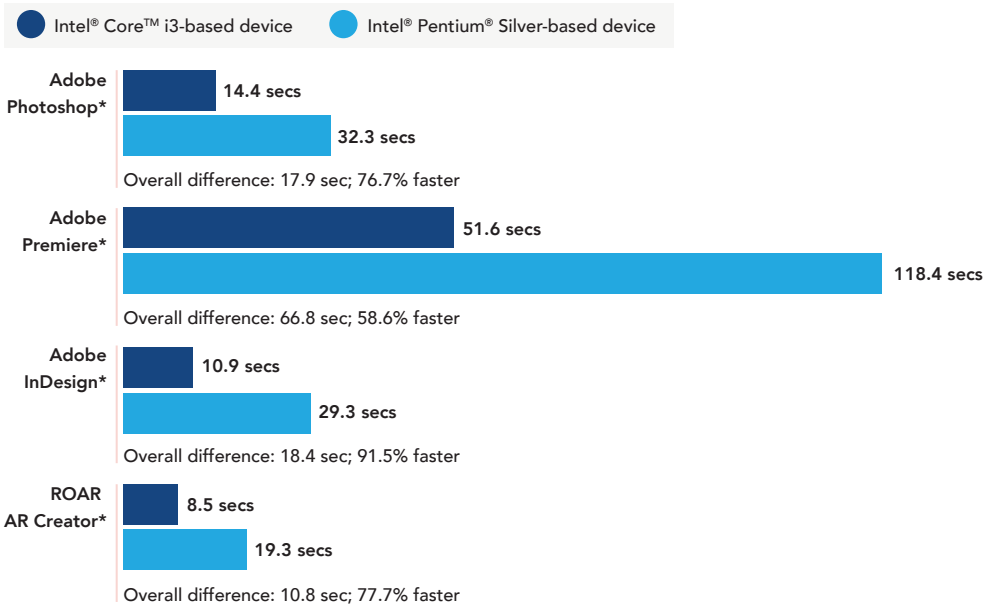
Test Results: Highlights

For this learning scenario, the fastest device, the Intel® Core™ i3-based device, completed all the steps on average 133 seconds faster than the Intel® Pentium® Silver-based device. At 129% faster processing speed, the Intel® Core™ i3-based device offers students a smoother and more uninterrupted learning experience when multitasking across programs for digital content and AR creation.

The effects of processor speed on this remote learning scenario can be seen in how fast the devices were able to export, load, and create digital content across applications. When exporting a video file optimized for mobile devices, the Intel® Core™ i3-based device performed 54.3 seconds, or 143.8% faster than the Intel® Pentium® Silver-based device. The Intel® Core™ i3-based device also performed faster on loading applications, such as Adobe InDesign*, where it was 14.2 seconds, or 220.7% faster than its counterpart. When creating AR content using the ROAR* application, the Intel® Core™ i3-based device performed 10.8 seconds, or 126.2% faster than the Intel® Pentium® Silver-based device.

	Intel® Pentium® Silver	Intel® Core™ i3
Exporting Adobe Premiere* video	92.0 secs	37.7 secs
Loading Adobe InDesign*	20.6 secs	6.4 secs
Creating a ROAR AR project	19.3 secs	8.5 secs

Table 6: Notable test results from the 9th grade remote learning scenario.



Appendix

A. Device Specifications

		
Device	**HP* ProBook* x360 11 G5 EE**	**Dell* Inspiron* 15**
Model Number	AX200NGW	i3593-3582BLK
Operating System	Microsoft* Windows* 10 Home (64-bit)	Microsoft* Windows* 10 Home (64-bit)
Processor	Intel® Pentium® Silver N5030	Intel® Core™ i3-1005G1
Processor Frequency	1.1 GHz	1.20 GHz
Storage	128 GB	128 GB
Memory	8 GB	8 GB
Battery Capacity	48 Whr	42 Whr
Display Size	11" Touchscreen 1366 x 768"	15.6" Touchscreen 1920 x 1080"
Graphics	Intel® UHD Graphics	Intel® UHD Graphics
Camera	Integrated Webcam	Integrated Webcam
Audio	Stereo speakers	Stereo speakers
Networking	802.11ac	802.11ac
USB / ports	2x USB 3.1 Gen 1 1x USB Type-C 1x HDMI 2.0a 1x RJ-45 1x Combo audio jack	2x USB 3.1 Gen 1 1x USB 2.0 1x Combo audio jack 1x HDMI 1x RJ45 1x SD card reader
Bluetooth	Bluetooth® 5.0	Bluetooth® 4.2
Price at Time of Purchase	$569	$598
Dimensions	11.8 x 8.8 x 0.83 in	14.96 x 10.16 x 0.89 in
Weight	3.16 pounds	5.94 pounds

B. Device Test Results

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 1

Test	Dell* Inspiron* 15					HP* ProBook* x360 11 G5				
Microsoft Teams	**Pre-test**	**1**	**2**	**3**	**average**	**Pre-test**	**1**	**2**	**3**	**average**
1. Join a Teams Meeting	3.1	3.7	2.9	2.7	3.1	2.3	2.5	3.2	3.2	3.0
Total for all subtasks	*3.1*	*3.7*	*2.9*	*2.7*	*3.1*	*2.3*	*2.5*	*3.2*	*3.2*	*3.0*
Minecraft: Education Edition										
1. Download mcworld file onto device	2.9	3.0	1.9	1.8	2.2	2.6	2.3	2.2	2.6	2.4
2. Launching and generating Mindful Knight world	19.0	14.5	14.5	14.7	14.6	18.8	19.3	20.2	19.7	19.7
3. Load Immersive Reader with NPC	4.7	1.7	1.1	3.1	2.0	8.0	2.2	2.7	3.7	2.9
4. Screen recording and saving video with Game Bar	1.7	1.3	1.3	1.1	1.2	0.8	1.2	0.8	1.5	1.2
Total for all subtasks	*28.3*	*20.5*	*18.8*	*20.7*	*20.0*	*30.2*	*25*	*25.9*	*27.5*	*25.0*
Flipgrid										
1. Posting screen recording to grid	1.0	0.6	0.9	0.7	0.7	1.1	1.7	1.4	1.1	1.4
Total for all subtasks	*1.0*	*0.6*	*0.9*	*0.7*	*0.7*	*1.1*	*1.7*	*1.4*	*1.1*	*1.4*
Scenario Total (Seconds)	***32.4***	***24.8***	***22.6***	***24.1***	***23.8***	***33.6***	***29.2***	***30.5***	***31.8***	***29.3***

Scenario 2

Test	Dell* Inspiron* 15					HP* ProBook* x360 11 G5				
Microsoft Teams	**Pre-test**	**1**	**2**	**3**	**average**	**Pre-test**	**1**	**2**	**3**	**average**
1. Download project hex file	6.0	5.1	5.2	5.0	5.1	4.1	3.7	3.9	3.2	3.6
2a. Load project hex file	*4.5*	*4.4*	*4.7*	*4.1*	*4.4*	*5.8*	*6.5*	*6.1*	*6.4*	*6.3*
2b. Load project hex file with open in Makecode	*7.2*	*6.5*	*5.3*	*6.8*	*6.2*	*8.8*	*8.1*	*8.5*	*8.3*	*8.3*
3. Change from block coding to Javascript	*1.2*	*0.8*	*0.5*	*0.7*	*0.7*	*1.0*	*1.3*	*1.1*	*0.8*	*1.1*
4. Export hex file	*5.3*	*5.2*	*5.2*	*5.1*	*5.2*	*4.2*	*4.2*	*3.7*	*4.2*	*4.0*
Total for all subtasks	*24.2*	*22*	*20.9*	*21.7*	*21.5*	*23.9*	*23.8*	*23.3*	*22.9*	*23.3*
Micro:bit										
1.Flash hex file	2.3	2.2	2.4	2.5	2.4	3.3	2.6	2.8	2.7	2.7
Total for all subtasks	*2.3*	*2.2*	*2.4*	*2.5*	*2.4*	*3.3*	*2.6*	*2.8*	*2.7*	*2.7*
Microsoft Excel										
1. Launch program	1.0	1.0	0.8	1.1	1.0	2.0	2.2	1.8	1.9	2.0
2. Connect to Micro:bit	2.2	2.0	2.0	2.2	2.1	4.2	4.1	3.9	4.3	4.1
Total for all subtasks	*3.2*	*3.0*	*2.8*	*3.3*	*3.0*	*6.2*	*6.3*	*5.7*	*6.2*	*6.1*
Zoom										
1. Joining a video call	4.9	5.1	5.1	4.8	5.0	7.1	6.6	7.3	6.9	6.9
2. Download video recording file	13.5	13.5	12.2	12.0	12.6	21.0	20.9	21.0	21.3	21.1
Total for all subtasks	*18.4*	*18.6*	*17.3*	*16.8*	*17.6*	*28.1*	*27.5*	*28.3*	*28.2*	*28.0*
OneDrive										
1. Upload files to OneDrive folder	5.7	5.6	5.5	5.7	5.6	6.9	6.7	6.7	6.5	6.6
Total for all subtasks	*5.7*	*5.6*	*5.5*	*5.7*	*5.6*	*6.9*	*6.7*	*6.7*	*6.5*	*6.6*
Scenario Total (Seconds)	***53.8***	***51.4***	***48.9***	***50.0***	***50.1***	***68.4***	***66.9***	***66.8***	***66.5***	***66.7***

Scenario 3

Test	Dell* Inspiron* 15					HP* ProBook* x360 11 G5				
Microsoft Whiteboard	**Pre**	**1**	**2**	**3**	**average**	**Pre**	**1**	**2**	**3**	**average**
1. Loading application	2.0	2.4	2.2	2.1	2.2	3.2	3.3	3.2	3.2	3.2
2. Exporting whiteboard	*0.8*	*0.9*	*1.1*	*0.9*	*1.0*	*1.0*	*1.3*	*1.4*	*1.3*	*1.3*
Total for all subtasks	*2.8*	*3.3*	*3.3*	*3.0*	*3.2*	*4.2*	*4.6*	*4.6*	*4.5*	*4.6*
Adobe Photoshop										
1. Loading the program	8.9	9.1	8.1	8.0	8.4	22.3	13.7	12.3	12.4	12.8
2. Creating a project	4.9	1.0	6.2	1.2	2.8	18.6	6.3	5.1	6.4	5.9
3. Exporting a project	3.3	3.2	3.2	3.3	3.2	15.6	10.3	15.0	15.3	13.5
Total for all subtasks	*17.1*	*13.3*	*17.5*	*12.5*	*14.4*	*56.5*	*30.3*	*32.4*	*34.1*	*32.3*
Adobe Premiere										
1. Loading the program	13.5	10.8	10.7	11.4	11.0	50.6	16.0	20.3	14.8	17.0
2. Creating a project	2.1	1.8	1.6	1.8	1.7	8.2	2.8	3.1	8.7	4.9
3. Importing assets	2.1	1.3	1.3	1.0	1.2	4.1	3.4	5.0	5.1	4.5
4. Exporting a video	36.1	38.7	37.0	37.5	37.7	90.0	90.0	96.0	90.0	92.0
Total for all subtasks	*53.8*	*52.6*	*50.6*	*51.7*	*51.6*	*152.9*	*112.2*	*124.4*	*118.6*	*118.4*
Adobe Indesign										
1. Loading the program	8.2	6.5	6.5	6.3	6.4	17.0	18.8	17.8	25.3	20.6
2. Opening a saved project	3.3	3.5	1.5	3.5	2.8	14.3	5.6	6.2	8.1	6.6
3. Exporting the project	2.0	2.0	1.6	1.3	1.6	6.6	2.1	2.3	1.8	2.1
Total for all subtasks	*13.5*	*12.0*	*9.6*	*11.1*	*10.9*	*37.9*	*26.5*	*26.3*	*35.2*	*29.3*
ROAR AR Creator										
1. Loading the tool	7.2	2.0	2.1	2.3	2.1	3.3	3.0	3.6	3.8	3.5
2. Importing image marker	1.2	0.8	1.0	1.0	0.9	3.6	3.8	3.9	3.9	3.9
3. Saving ROAR content	6.0	5.7	5.4	5.3	5.5	10.3	12.5	11.8	11.6	12.0
Total for all subtasks	*14.4*	*8.5*	*8.5*	*8.6*	*8.5*	*17.2*	*19.3*	*19.3*	*19.3*	*19.3*
Scenario Total (Seconds)	***118.7***	***103.0***	***107.0***	***99.4***	***103.1***	***325.2***	***223.2***	***239.4***	***245.8***	***236.1***

C. Scenario Testing Details

Lesson Scenario 1

Simulate browser workload

Set the browser

1. From the desktop, open Edge*.
2. Navigate to the Open Microsoft Edge* With section of the settings, and select A Specific Page Or Pages.
3. 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
4. Restart Microsoft Edge* and ensure the pages load as expected.

*Microsoft Teams**

Join a video call

1. Simultaneously start the timer and click the link for Teams* video call.
2. When the video call fully connects, stop the timer.

*Minecraft: Education Edition**

Download mcworld file

1. From the desktop, open Edge*.
2. Paste the URL: https://education.minecraft.net/lessons/the-mindful-knight into the browser.
3. Simultaneously start timer and click Mindful Knight mcworld file link to download.
4. When the file is fully downloaded onto the device, stop the timer.

Launch program and generating world

1. Simultaneously start the timer and open Minecraft: Education Edition* program.
2. When the program fully loads and generates the Mindful Knight world, stop the timer.

Load Immersive Reader

1. Navigate to a NPC in-world.
2. Right click to access the player's speech bubble.
3. Simultaneously start the timer and click the Immersive Reader icon.
4. When Immersive Reader has fully loaded, stop the timer.

Screen record and save video

1. Open Game Bar* (windows button + g).
2. Click the start screen recording button.
3. Record screen for three minutes.
4. Simultaneously start the timer and click the stop recording button.
5. When the file has fully rendered and saved in the folder, stop the timer.

*Flipgrid**

Post screen recording

1. Click next and snap a selfie.
2. Simultaneously start the timer and click next.
3. When the video is fully prepared and posted, stop the timer.

Lesson Scenario 2

Simulate browser workload

Set the browser

1. From the desktop, open Edge*.
2. Navigate to the Open Microsoft Edge* With section of the settings, and select A Specific Page Or Pages.
3. 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
4. Restart Microsoft Edge* and ensure the pages load as expected.

*Microsoft Makecode**

Download project hex file

1. From the desktop, open Edge*.
2. Navigate to https://microbit.org/projects/make-it-code-it/step-counter/.
3. Simultaneously start the timer and download project hex file.
4. When the hex file is fully downloaded, stop the timer.

Load project hex file

1. Navigate to https://makecode.microbit.org/.
2. Click import file.
3. Click open.
4. Simultaneously start the timer and click open go ahead to load the project hex file.
5. When the project fully loads, stop the timer.

Load project hex file (alternative test)

1. From the desktop, open Edge*.
2. Navigate to https://microbit.org/projects/make-it-code-it/step-counter/.
3. Simultaneously start the timer and click Open in Makecode*.
4. When the project fully downloads and opens, stop the timer.

Change from block coding to Javascript coding

1. Simultaneously start the timer and click the drop down menu at the top to choose Javascript.
2. When the program fully loads, stop the timer.

Export hex file

1. Simultaneously start the timer and import hex file to Micro:bit* file folder.
2. When the file is fully copied, stop the timer.

*Microsoft Excel**

Launch Microsoft* Excel*

1. Simultaneously start the timer and open Microsoft Excel* from the task bar.
2. When the program fully loads, stop the timer.

Connect to Micro:bit*

1. From the desktop, open Microsoft Excel*.
2. Create a new spreadsheet.
3. Click the data streamer tab.
4. Simultaneously start the timer and click connect your device to select the micro:bit USB device.
5. When the Micro:bit* device is connected, stop the timer.

*Zoom**

Join a video call

1. Click the link to join the Zoom* video call.
2. Simultaneously start the timer and click open.
3. When the video call fully connects, stop the timer.

Download video recording

1. Click record to begin recording Zoom* video call.
2. Record for three minutes.
3. After the call is finished, click stop recording.
4. Click end.
5. Simultaneously start the timer and click end meeting for all.
6. When the video fully downloads, stop the timer.

*Microsoft OneDrive**

Upload files

1. From the desktop, open Edge*.
2. Navigate to OneDrive* account.
3. Click upload.
4. From the file finder, select the Test Project folder (10.805 MB) from the desktop (*hex file, Zoom* video and audio files, and csv file*).
5. Simultaneously start the timer and click upload.
6. When the folder fully uploads, stop the timer.

Lesson Scenario 3

Simulate browser workload

Set the browser

1. From the desktop, open Edge*.
2. Navigate to the Open Microsoft Edge* With section of the settings, and select A Specific Page Or Pages.
3. 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
4. Restart Microsoft Edge* and ensure the pages load as expected.

Gather media assets

Download an image

1. From the desktop, open Edge*.
2. From Microsoft Edge* browser, create a new tab and navigate to Pixabay.com.
3. Sign in with a Google* account.
4. Navigate to the image at https://pixabay.com/photos/mountains-bergsee-lake-1645078/ (5472×3147 JPG 6.1MB)
5. Click Free Download, select the 5472x3147 option, and click Download.
6. Choose save As.
7. Select desktop as location.
8. Set filename to "study_abroad_image".
9. Click save.

Download a video

1. From the desktop, open Edge*.
2. From Microsoft Edge* browser, create a new tab and navigate to Pixabay.com.
3. Sign in with your Google* account.
4. Navigate to the video at https://pixabay.com/videos/from-the-air-from-above-9798/ (4096×2160 MP4 119.6 MB)
5. Click Free Download, select the 4096x2160 option, and click download.
6. Choose save as and choose the desktop as the location.
7. Set filename to "study_abroad_video".
8. Click Save.

*Microsoft Teams**

Join a video call

1. Simultaneously start the timer and click the link for Teams* video call.
2. When the video call fully connects, stop the timer.

*Microsoft Whiteboard**

Load application

1. Simultaneously start the timer and open Microsoft Whiteboard* application from the taskbar.
2. When the program fully loads, stop the timer.

Edit whiteboard

1. Click the image icon in the application taskbar.
2. From the file selector, choose "study_abroad_image".
3. Click the + icon and add a list, a notegrid, and a follow-ups list.
4. Click the sticky note icon and add a sticky note.

Export whiteboard

1. Click the 3 bar menu on the right side of the application screen.
2. Click export.
3. Choose png for the image type.
4. In the file selector, choose desktop and name the image.
5. Simultaneously start the timer and click save.
6. Stop the timer when the image fully loads.

*Adobe Photoshop**

Load the program

1. Simultaneously start the timer and open Adobe Photoshop*.
2. When the program fully loads, stop the timer.

Create a project

1. Click open.
2. From the file finder, locate the file "study_abroad_image".
3. Simultaneously start the timer and choose Open.
4. When the project fully loads, stop the timer.
5. Add text to the project.

Export the project

1. Choose file > export > export as.
2. Set save as type to PNG.
3. Set filename to "study_abroad_titlecard".
4. Set the location to the desktop.
5. Click Export.
6. Simultaneously start the timer and click ok.
7. When the project fully exports, stop the timer.

*Adobe Premiere**

Load the program

1. Simultaneously start the timer and open Adobe Premiere*.
2. When the program fully loads, stop the timer.

Create a project

1. Choose new project..
2. Simultaneously start the timer and click ok.
3. When the project fully loads, stop the timer.

Import assets

1. Go to file > import.
2. Select both the "study_abroad_titlecard" and "study_abroad_video".
3. Simultaneously start the timer and click open.
4. When the assets fully import, stop the timer.
5. Drag these imported files from the media browser to the timeline.
6. Clip the video to 10 minutes.

Export the video

(Project Settings: General; Renderer: Mercury Playback Engine Software Only)

(Export Preset: H264, Mobile device 2160p 4K)

1. Go to file > export > media.
2. Set format to H264.
3. Simultaneously start timer and click export.
4. When video is fully exported, stop the timer.

*Adobe InDesign**

Download template file

1. Navigate to https://edex.adobe.com/en/resource/vb48e6dd5.
2. Download zip file onto desktop.
3. Unzip files.
4. Save one InDesign* file as "Yearbook_template".

Load the program

1. Simultaneously start the timer and open Adobe InDesign*.
2. When the program fully loads, stop the timer.

Open saved project

1. Click open.
2. From the file finder, choose "Yearbook_template".
3. Simultaneously start the timer and click open.
4. When the project fully loads, stop the timer.
5. Add images project.

Export the project

1. Go to file > export.
2. Set format to PDF.
3. Simultaneously start timer and click export.
4. When pdf is fully exported, stop the timer.

*ROAR**

Load the application

1. From the desktop, open Edge*.
2. Navigate to https://account.theroar.io/dashboard.
3. Log in to account.
4. Click create roar.
5. Simultaneously start the timer and click select for target image.
6. When the application fully loads, stop the timer.

Import image marker

1. Click upload image.
2. From the file finder, choose "study_abroad_titlecard".
3. Simultaneously start the timer and click okay.
4. When the image is fully loaded, stop the timer.
5. Click use this marker.
6. Upload the "study_abroad_titlecard" video.
7. When it has fully uploaded, click save.

Save and publish ROAR* content

1. Simultaneously start the timer and click save it to my ROARs.
2. When the project is fully saved, stop the timer.

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