



Digital Paper in Education

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The past decade has brought a wave of digitalization to North American classrooms, making laptop computers and smartphones ubiquitous. Policymakers and education leaders set an ambitious goal of getting a laptop into the hands of every student, a “one-to-one” ratio designed to help every child thrive in our increasingly digital age.

The growth in the adoption of devices has been paired with rapidly growing access to digital content such as eTextbooks. College students struggling with debt spend an average of \$484 on required course materials in any given academic year.¹ But with increasingly popular eTextbook rentals students can reduce their costs by 60 percent or more. The digital education publishing market is projected to grow by 12 percent yearly through 2023² — a projection that in light of increased remote learning due to the pandemic may prove to be too low. “We’ve seen double the number of courses that have adopted digital materials,” reports Tom Scotty, COO of RedShelf, a leading eTextbook provider.

Technology makes education more affordable, gives students rapid access to knowledge, and makes it easy for students to type up copious lecture notes. However, the headlong rush to get technology into the hands of students has come at a cost. Researchers are finding that some technologies can actually hold students back, impairing their ability to learn while frustrating teachers and parents.

“When a professor is lecturing over a sea of students staring intently at their laptops, they get discouraged.”

— Harvard University Derek Bok Center for Teaching and Learning

Laptops and smartphones are by nature multipurpose devices, allowing students to type their notes, research topics on the internet, and take quick breaks to see the latest Facebook and Instagram posts. Or Tweets. Or texts. Or play a game. Or a hundred other things. Some students might claim they can multitask, but scientists have demonstrated that human beings are simply not hardwired for it.³ All these interruptions take a toll. In a survey taken at six universities, students reported using their smartphones 11 times per day in class on average.⁴ Another study found that 92 percent of students sent text messages in class.⁴ Students who texted frequently retained less information, took lower quality notes, and did worse on tests. One study on laptop use concluded that just being near another student who was multitasking on a laptop during class resulted in poorer grades.⁴ “Put screens in front of children and they aren’t thinking ‘I can’t wait to do research,’ they’re thinking ‘Let’s play Candy Crush,’” says Melanie Hempe, founder of ScreenStrong.

Handwriting versus typing = quality over volume.

Laptops have made it easy for students to type lecture notes quickly and accurately, but sometimes at the expense of actual thinking. Harvard’s Graduate School of Education reports that “a series of randomized trials have shown that when college students use computers or tablets during lectures, they learn less and earn worse grades.”⁵ Why? The secret lies in one of the oldest tools used in learning and communications: the humble pen. Writing with a pen has been common practice since at least the 4th millennium B.C., but it’s only recently that researchers have discovered just how important it is to the learning process. In a study published by the Association for Psychological Science,⁶ researchers found that “laptop note takers’ tendency to transcribe lectures verbatim rather than processing information and reframing it in their own words is detrimental to learning.” In other words, the process of handwriting notes forces us to interpret what we hear and actually think about it. The difference pen usage makes can be substantial, enabling between a 9 to 38 percent improvement in cognition.⁷

Studies have found that handwriting and drawing requires fluid hand motions that trigger creative thinking,⁸ an increasingly valuable skill to prepare students for career success. In fact, a report from the World Economic Forum on the Future of Jobs ranked creativity number three on their top 10 skills for 2020.⁹

Handwriting matters not just to college students, but to very young students as well. A paper published by Indiana University¹⁰ found that the physical process of handwriting as a sensorimotor experience augments processing in the visual system of preschool children.

The next generation of digital education technology: dedicated eNotes.

Recognizing an opportunity in the education market, innovative companies have launched products that bridge the gap between handwriting, paper and computing. Pen-based tablets, called eNotes, bring together the learning power of handwriting with affordable access to eTextbooks — all without the distraction inherent to laptops and smartphones. At the heart of eNote technology is digital paper, which looks and feels like paper. Students can handwrite lecture notes on screens, or mark up their eTextbooks with notes

or highlights. Pioneered by E Ink, digital paper was first popularized in eReaders like the Kindle, but today it's available in a whole range of sizes for numerous applications. Digital paper technology features particles within microcapsules or microcups that are coated onto a thin film layer and act as a form of ink. Instead of ink being pressed permanently upon paper, however, the ink particles in digital paper are automatically recycled to form new letters and images when the display image is updated.

Low power consumption for greater sustainability.

Screens made with digital paper require only a tiny fraction of the power required to run other types of screens. In fact, an E Ink display uses about 99 percent less power than the liquid crystal displays (LCD) used in laptop and tablet screens and many types of mobile devices. And unlike light-emitting LCD screens, E Ink screens are reflective — just like print. This makes them easy to read even in broad daylight, with a more natural paper-like feeling. Sustainable digital paper screens are attractive to both students and universities seeking to lower their carbon footprint. Hundreds of universities have signed on as signatories to the Climate Leadership Network,¹¹ pledging to take action on climate change. Saving energy one screen at a time can add up to major change when multiplied by thousands of devices. Students not only prefer to be green, they're pressuring their schools to be green as well.¹²



The Onyx Boox Note2 provides a highly focused learning experience that's easy on the eyes.

Onyx Boox. The dedicated learning tool for today's students.

Onyx International, a leading Chinese consumer electronics company, offers the Boox Note2 for the education market, incorporating a 10.3-inch E Ink screen. Based on an Android 9.0 system, Boox allows for a paper-like reading and note-taking experience, and is supported with 16 text file formats. While Boox eNotes are Wi-Fi connected they're not designed for social media, allowing students to focus on their textbooks or lectures in the moment. Students can access all kinds of documents for reading, note taking and highlighting. Handwritten notes can be instantly converted to text and uploaded to the cloud for later access or sharing with other students. For eTextbook publishers, the cloud-based nature of the Boox platform makes it possible to publish custom, branded content affordably. In addition to allowing for focused learning experiences, Boox' E Ink screens help avoid the eyestrain common with laptop screens.

QuirkLogic. An integrated platform for remote learning during and after the pandemic.

As teachers transitioned to remote learning, one of their challenges was providing an engaging learning environment that enabled formative assessment. Simply put, formative assessment is defined as the continuous process of interacting with students to see if they're mastering subjects. It's a challenge when teachers and students are in the same room, and much harder when everyone is remote. QuirkLogic, a Canadian company, may have found the ideal solution for any teaching situation.

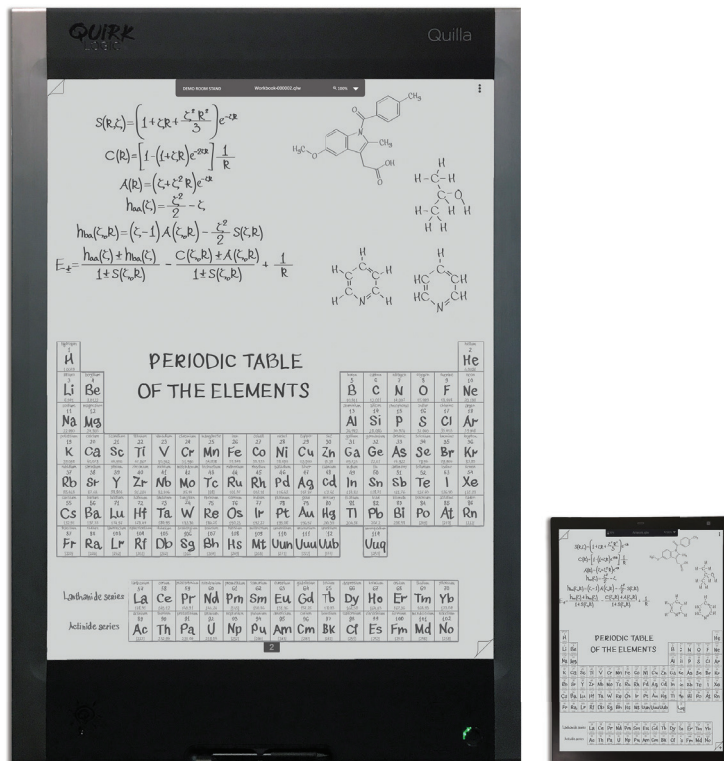


Photo courtesy of QuirkLogic.

QuirkLogic offers an integrated system for remote learning that can be scaled for any number of students. While digital handwriting is of value for teaching all kinds of subject matter, it's essential for topics that involve diagrams and symbols.

Designed for active learning, there are two main components to QuirkLogic's system. The first is the Quilla whiteboard for teachers, the second is Papyr — a personal eNote device for both students and teachers. Quilla, with a 42-inch E Ink screen, lets teachers write on it with a digital pen just as they would on an analog whiteboard. Everything the teacher writes and sketches appears in real-time on the students' Papyr devices, which are made with 13-inch E Ink displays. For example, teachers can periodically pose questions to students to keep them engaged and see if they understand the lesson. Students can write answers on their Papyr devices, which the teacher can see instantly displayed on their Quilla device whether they're in the same lecture hall or a thousand miles apart. Without social media distractions, dedicated Papyr eNotes provide a highly focused learning experience. During lectures, students can make handwritten notes on their Papyr eNotes, share them with other students, and receive instructor notes in real-time.

Both devices provide easy access to content through built-in integration with Google Drive and Dropbox. eTextbooks can be uploaded to Papyr devices, where students can write on them or highlight the text. And students and teachers never have to worry about saving their handwritten content. Every ink stroke is saved for them, either locally on the student's device, or stored in the cloud for live sharing and future reference.

reMarkable: Sleek design with a sophisticated interface that appeals to students and creative professionals.

At just .19 inches, the reMarkable eNote tablet, made with a 10.3-inch E Ink display, is the thinnest on the market, making for a comfortable handwriting and sketching experience. The company describes its next generation eNote, reMarkable 2, as a “visualization power tool,” enabling a natural writing and drawing experience geared toward unleashing creativity. As with other eNotes, documents such as PDF files can be easily imported. Users can make notes on the documents and share them with others, and have their handwritten notes converted to text. Thanks to a sophisticated and intuitive file management system, handwritten notes and documents can be easily organized into folders.



Photo courtesy of reMarkable.

The reMarkable 2 is the world's thinnest eNote tablet.

Conclusion.

The advance of technology in the classroom shows no sign of slowing down, and more innovation is on the way. Laptops and smartphones keep students connected, informed and productive in ways that weren't possible during prior eras. But the very connectivity of these devices, combined with their reliance on typing, presents real challenges to educators and parents seeking optimal academic performance. When we as a society take steps forward with technology — often at breakneck speeds — we would be wise to pause now and then to ask, “What are we losing in the process?” States such as California and Texas have reinstated handwriting as a core requirement for students. Writing in cursive will, thankfully, survive during our ongoing digital transformation.

We're now entering a period where the best of the old — the tactile sense of writing with a pen and paper and all the learning benefits that go with it — will live in harmony with advanced eNote digital devices. In the years ahead, eTextbook providers will likely explore new business models that will make content even more affordable, while bringing pens back into student life. And parents concerned about excessive screen time will be able to provide their kids with a healthy, highly focused reading and note-taking experience. In this changing educational landscape, E Ink's digital paper will play a growing role in expanding the light of knowledge.

About the Author

Ted Page is a Co-Founder and Principal of Captains of Industry. Page has created content and marketing for a wide range of global companies including Apple, Microsoft and Starbucks.

About the Sponsor

E Ink is the originator, pioneer and commercial leader in digital paper technology. The company delivers its advanced display products to the world's most influential brands and manufacturers, enabling them to install extremely durable, low-power displays in previously impossible or unimaginable applications and environments.

E Ink encompasses the combined E Ink Corporation, which was spun out of the MIT Media Lab in 1997 to commercialize electronic ink and EPD technology, and Prime View International, which was established in 1992 as the first TFT LCD company in Taiwan, focusing on high-quality small-to-medium-sized TFT LCDs. In 2009, Prime View acquired E Ink Corporation to further integrate and expand the EPD supply chain and the new combined companies were branded as E Ink.

E Ink's corporate philosophy centers around delivering revolutionary products, excellent user experiences, and environmental benefits through advanced technology development.

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