Augmented Reality

Time-to-Adoption Horizon: Four to Five Years

Augmented reality (AR), a capability that has been around for some time, is shifting from what once required rooms of equipment to a set of simple-to-use tools with tremendous potential. The layering of information over 3D space produces a new experience of the world, sometimes referred to as "blended reality," bringing with it new expectations regarding access to information and new opportunities for learning. While the most prevalent uses of augmented reality so far have been in the consumer sector (for marketing, social engagement, amusement, or location-based information), new uses seem to emerge almost daily, as tools for creating new applications become even easier to use. A key characteristic of augmented reality is its ability to respond to user input. This interactivity confers significant potential for learning and assessment; with it, students can construct new understanding based on interactions with virtual objects that bring underlying data to life.

Overview

The concept of blending — or augmenting — what we see in the real world with related information, data, media, and even live action is a powerful one. Augmented reality aims to do just that as a means to enhance the information we can perceive with our senses. The first modern application of augmented reality was when a cinematographer developed a simulator in the early 1960s that incorporated visuals, smells, and vibrations. By the 1990s, augmented reality was being put to use by a number of major companies for visualization, training, and other purposes. Now, the technologies that make AR possible are powerful and compact enough to deliver augmented reality experiences to personal computers — and even mobile devices. Early mobile applications began to appear in 2008, and now many AR applications and tools for mobiles are on the market.

Augmented reality applications can either be marker-based, which means that the camera must perceive a specific visual cue in order for the software to call up the correct information, or markerless. Markerless applications use positional data, such as a mobile's GPS and compass, or image recognition, where input to the camera is compared against a library of images to find a match. Markerless applications have wider applicability since they function anywhere without the need for special labeling or supplemental reference points. Layar (go.nmc.org/rfomi) has been a leader in this space with augmented reality applications for the Android and iPhone platforms. Layar Vision is a markerless application of AR that makes it easy to develop apps that can recognize real world objects and overlay information on top of them.

In the commercial and entertainment sectors, augmented reality has been used so effectively, it is often not even noticed by the casual observer. For example, the floating yellow line that appears in telecasts of American football games is an AR application that represents where a team must drive to reach a "first down." Games were quick to integrate the technology, and early examples such as *Halo* and *Rainbow Six* made the presentation of "heads up" data commonplace. In both of these examples, most observers see the added information as simply part of the experience.

Today, advancements both in AR technology and mobile capabilities are increasingly driving this technology into the handheld space. The cameras and screens in smartphones, tablets and other mobile devices now serve as uniquely convenient tools to combine real world data with virtual data. Sensor-based AR uses GPS

capability, image recognition, and the devices' built-in compasses to pinpoint where a mobile device is on the planet and where its camera is pointing, and then use that information to overlay relevant facts, data, or visuals at appropriate points on the screen.

While augmented reality has appeared in several previous editions of the *NMC Horizon Report*, always on the mid- or far-term horizon, what makes it fresh this year is the announcement of Google's Project Glass (go.nmc.org/proje). Up until this point, many augmented reality products and services relied on webcams and smartphone cameras to layer information over images. In the case of Project Glass, users actually wear the device; information, entertainment, and a variety of content are layered directly into their line of vision. Since Google's announcement, a growing list of companies is stepping up to compete with similar products of their own. The popular sportswear line Oakley, for example, is already planning the release of its own heads-up display technology, designed especially to aid athletes.

The most common uses of augmented reality currently are in entertainment and marketing, but schools are likely to follow as the technology matures and becomes even more simplified. Museum and cultural organizations are the first of the learning sectors to frequently and effectively use augmented reality, and the lessons learned there are easily applicable to schools. For example, a groundbreaking project by the City of Philadelphia Department of Public Records has used sensor-based augmented reality as a way to showcase some 93,000 historic photographs from the city's archives. Working with geographic services company, Azavea, they mapped the entire *PhillyHistory* collection.

Relevance for Teaching, Learning, or Creative Inquiry

One of the most promising aspects of augmented reality is that it can be used for visual and highly interactive forms of learning, allowing the overlay of data onto the real world. Augmented reality is an active, not a passive technology; students can use it to construct new understanding based on interactions with virtual objects that bring underlying data to life as it responds to user input. Dynamic processes, extensive datasets, and objects too large or too small to be manipulated can be brought into a student's personal space at a scale and in a form easy to understand and work with. Students find connections between their lives and their education through the addition of a contextual layer.

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The ability to transfer learning from one context to another is a significant skill, one that AR can facilitate in its overt use of context and layering.

AR that relies on mobile devices leverages an increasingly ubiquitous tool that is blurring the boundaries between formal and informal learning. Indeed, the potential for just-in-time learning and exploration is a deeply compelling aspect of this technology.

Augmented reality has strong potential to provide powerful, contextual, *in situ* learning experiences and serendipitous exploration and discovery of the connected nature of information in the real world. One of the easiest ways to visualize that potential is the ease with which it can make invisible things visible, such as the X-ray pictures or the preparatory drawings of a centuries-old painting, or to restore things to a previous state, such as illustrating the way the Berlin Wall appeared before it was torn down. Most of the activity happening in this area is taking place in universities and at museums, but the work going on there can easily be transferred to K-12 settings. Museums commonly use simple AR tools to provide straightforward, yet

engaging visuals and facts that are "layered" over objects or physical settings when viewed through phones or tablets. Providing students layered information about a historical object is a simple approach to giving students a deeper learning experience.

Augmented reality first appeared in the 2010 edition of this report, also on the far-term horizon, which signifies the technology's lack of movement in the K-12 sector. It still remains a consumer-driven technology with limited research and use case examples specifically occurring in schools.

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A sampling of applications of augmented reality across disciplines includes the following:

> **Art History.** San Diego's School in the Park developed an augmented reality experience for its students built around a Chinese folktale. The activity required students to work through academic problems associated with the materials found in the San Diego Museum of Art's Asian Art Exhibit. At each step, the students interact with the items through a handheld computer that triggers a geographic location using Layar technology. go.nmc.org/sandi

> **Reading.** "Letters Alive" is a supplemental reading program utilizing augmented reality to teach children ages 4-8 how to read. Animal and vocabulary cards are placed under a 3Cam document camera to build sentences and display 3D like animations. This technology is leveraged to teach early literacy skills using research based best practices. go.nmc.org/letter

> **STEM.** At Super School University, an afterschool program, teachers and students from 34 countries are working as backpack journalists and scientists, using the uninhabited island of Santa Luzia, Cape Verde for a virtual collaborative STEM project. Custom software has been created for the project websites, computers, and mobile devices. go.nmc.org/stem

Augmented Reality in Practice

The following links provide examples of augmented reality in use that have direct implications for K-12 settings.

Augmented Reality for Special Education
go.nmc.org/augme
This wiki was launched to explore the applications of augmented reality for special education, specifically for deaf and blind students. Augmented reality glasses, for instance, have potential to serve as speech recognition aids to display text as others are talking, allowing freedom for a deaf individual to attend speaking engagements without a sign language interpreter.

BuildAR
go.nmc.org/build
BuildAR is a Layar-based augmented reality platform that allows people — even without development experience — to create and host mobile augmented reality content online. Student-created content can be enhanced with augmented reality in creative ways.

The Earthquake AR Project
go.nmc.org/earthq
The Earthquake AR project was started in response to the 2011 earthquake in Christchurch, New Zealand. The project is exploring how mobile augmented reality can reveal data sets that would be helpful in the reconstruction of a demolished building.

Getting Learning out of the Classroom with Augmented Reality
go.nmc.org/getti
One educator is exploring ways students can learn and interpret their surroundings using two free GPS-enabled apps that allow users to attach audio recordings and

other information to a particular place in order to augment reality.

LearnAR
go.nmc.org/learn
LearnAR is an augmented reality resource that makes use of a digital, video, or web camera to display virtual content layered over real world content. For example, to learn how the body works, major organs of the body are displayed on screen when the user points his webcam toward another person's chest. Students from subscribing schools can print out AR markers that then can display intricate 3D models for further examination.

Who Do You Think You Really Are?
go.nmc.org/uqthc
The London Natural History Museum developed an interactive dinosaur film optimized for tablets that incorporates gesture-based manipulation and augmented reality, where extinct creatures appear to roam the Attenborough Studio space.

For Further Reading

The following articles and resources are recommended for those who wish to learn more about augmented reality.

21st Century Lessons with Mobile Augmented Reality (Video)
go.nmc.org/lesso
(*K12 Mobile Learning*, 26 May 2011.) Mobile AR tools are a convenient way to augment classroom resources in a way that allows students to use their devices for discovering new or hidden content. This video displays how simple it can be to attach videos to handwritten text, creating a lively experience with paper, a pen, and a mobile device.

Augmented Reality: Coming Soon to a School Near You?
go.nmc.org/arcomi
(Sarah Jackson, *MindShift*, 20 April 2012.) Because the number of people who own a mobile device has drastically increased in the past five years, AR programs are more readily available. This article explores ARIS, an open source mobile learning platform that facilitates interactive storytelling through the use of augmented reality. Educators do not require any programming experience to start building their own games, specific to their curriculum.

Augmented Reality for Chemists (Video)
go.nmc.org/augm
(Art Olson, *Chemical & Engineering News*, 19 September 2011.) This video makes augmented reality easier to understand by demonstrating how it is built, using a webcam to track all the possible motions of a 3D model of a chemical.

Google's 'Project Glass' Augmented Reality Glasses Are Real And In Testing
go.nmc.org/glass
(Chris Velazco, *Tech Crunch*, 4 April 2012.) Google has revealed its augmented reality glasses model that will allow the user to do things like snap a photo on command, send a text by voicing it, and display the location of nearby friends. But the author of this article notes that it may be a while before we see these in public.

An Open Letter to Augmented Reality
go.nmc.org/openl
(Clark Dever, *Wired UK*, 13 February 2012.) This letter asserts a different perspective about the path that augmented reality has taken. The writer believes that there have not been adequate advancements in the technology given the level of buzz it has garnered. He urges augmented reality developers to leverage cloud-connect experiences and drop the notion of smartphone cameras and webcams as the sole looking glasses for augmented reality.

TEDxYouth: Marko Todorovic on AR
go.nmc.org/tedxy
(Marko Todorovic, TED, 8 December 2011.) Marko Todorovic of Live View Studio discusses and demonstrates benefits and applications of augmented reality to connect youth with educational content. Books and other objects become interactive when hidden information is displayed through a smartphone or other digital device.