Augmented Reality for Learning

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Augmented Reality is already in use in many curricula and programs for specialized instruction. Tools permitting tech-savvy educators to explore and implement AR in their materials are available today.

In the future, with easier to use development/design tools, one day any educator will be able to design new interaction for learning in situ.

Executive Summary

Augmented Reality offers a new approach to exploration and learning by blending reality—real world conditions—with digital data. AR appeals to marketers wishing to engage with consumers, but these same elements can engage learners in their quest for insights and experiences.

In the technology portfolio of educators, many tools are designed to meet a specific objective—to support inquiry, to provide practice and repetition without risk to a valuable resource or subject, to encourage creativity and collaboration. Augmented Reality is not one of those targeted tools—but maybe it will have the ability to inspire educators and learners to use technology fully for every day experiences, including learning.

Imagine you are helping a group of learners who have never seen an X-ray discover the human skeleton. Just like a circus sideshow in the 1930s, where anyone prepared to pay a few pennies could stand near a radioactive source and expose a film to produce an "X-ray," today, a student can stand in front of a Microsoft Kinect system and see a skeleton superimposed on themselves. Turn around and use the same basic principles with a smartphone to learn the names and heights of summits (example one, example two, example three). What do these learning experiences have in common?

Learning Applications for AR

Creating immersive and engaging experiences consistently increases the learner's retention of a solution or stimulates deeper understanding of facts or issues. Augmented Reality has been shown to accelerate comprehension and increase engagement with learners of all ages and in numerous disciplines, from geography and physics to culture and language.

Augmented Reality projects have been developed to enhance unusual objects, such as an aircraft engine, as well as a very traditional learning tool: a book. While examples of AR interacting with print are valuable, they are only one of the many materials that surround learners and educators. Let's examine a few disciplines that have been made more interesting using AR.

Science and Physics

An early showcase of using AR for learning geography was developed by metaio in mid-2008, using the company's Unifeye platform for AR and the "Big World Atlas." The project produced an interactive atlas that was made available during

the Frankfurt Book Fair, an international annual book buyer event. This particular work is only available in German, but the concept is easy to understand and could be implemented with the same models in any language.

Another project along these lines brings the solar system to life using a text book and a web cam The same principles can leave the classroom environment, using a smartphone, the Space Walk application encourages kinesthetic learning by bringing the solar system right into the neighborhood.

Connecting the spatial world with digital information can also help when discovering a new place using a map. Microsoft's Bing Maps director, Blaise Aguera y Arcas used Augmented Reality to show how maps might appear in the future. The demonstration used a combination of visual recognition and the user's onboard compass and GPS.

Discovering the physical properties of matter can be conceptually challenging when all a student has in hand is a piece of paper and a pencil. Take, for example, the learning of gravity and physics. Laboratory experiments are the most frequent way to bring principles to life today, but in projects using the "In-place 3D Sketching of Mechanical Systems" it was shown that students can combine their book learning with rapid and inexpensive materials to see physical concepts as they exert forces on 2D sketches. The system captures a mechanical system, analyses its properties, composing a 3D scene, and augments and animates the scene using a physical simulation engine. In the research conducted at Ben Guiron University, the system was shown to work equally well with hand sketches as figures from a text book.

Cultural Heritage

The exploration of the physical world is not limited to concepts. Augmented Reality is also used to help the discovery of cultural heritage that is tied to objects that have since disappeared. In one example, the Berlin Wall has been recreated and exists in virtual space when a user of the Layar Berlin Wall layer is in proximity of the former barrier between East and West Germany.

The LifeClipper project, implemented by researchers at the Academy of Art and Design, University of Applied Sciences Northwestern Switzerland, in Basel Switzerland, with the support of the national and municipal governments illustrates how a citizen can walk through the old city and relive where there would have been a covered market, domestic buildings and animals in the middle ages, complete with animations and sounds. The project is part of a nearly decade long study of the use of AR in urban spaces.

Many other historical landmarks—from the Summer Palace of the Ming Dynasty on the outskirts of Beijing to the barn in which the Wright Brothers built their first flying machines—have been enhanced with Augmented Reality.

Language

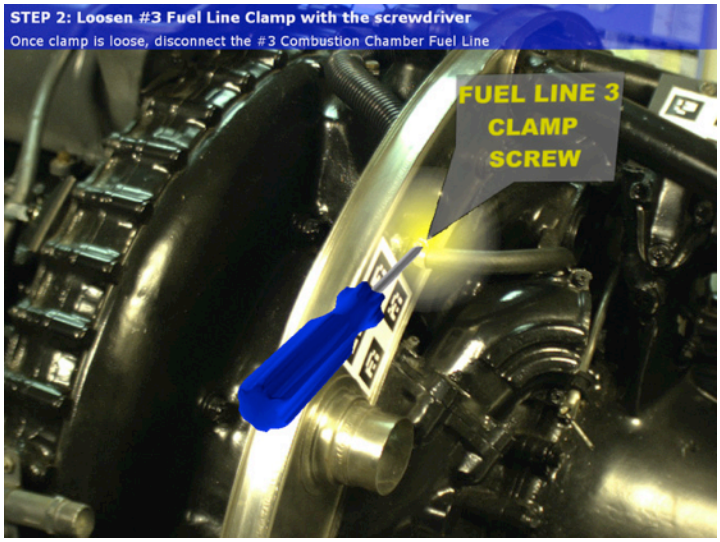
Perhaps one of the most fundamental skills a person can learn is the mastery of a new language. There are Augmented Reality applications that are helping this process for young learners as well as people of any age. The game *Put a Spell*,

developed for the iPhone by Ogmento uses an animated panda bear to help a child learn to spell. The Google Goggles and Word Lens applications provide the user the ability to instantly "read" a sign in a foreign language simply by holding the print in the field of view of the camera phone running the applications.

It's not difficult to imagine how these real world applications will help us to better understand our surroundings as well as those of different cultures and language groups.

Kinesthetic learning

As a result of having Augmented Reality be integral with the real world, it is clear that it can assist with the learning of physical skills. One example, undertaken by researchers in the Computer Vision Laboratory at the ETH in Zurich, has explored the use of haptic interfaces in combination with real and virtual objects to study and train "manipulative" skills in a surgical environment. While not in daily use, these tools are promising for practicing high risk procedures before undertaking them on real patients.



The U.S. Marine Corps has been testing the use of Augmented Reality to train mechanics to repair vehicles in the field. In the scenario developed at the Columbia University Computer Graphics and User Interfaces laboratory of Steve Feiner, parts of the engine and virtual representations of tools become animated and have labels associated with instructions hovering over them when viewed through a head mounted display. Studies conducted with marines demonstrated that AR was superior to using an electronic manual presented on an LCD screen.

Tools for Creating AR experiences

Now, the question you are asking yourself is how all these applications migrate from the graphics laboratory and the marines in the field to the world of every day learners. It's not as easy as building a Web page, but it isn't as difficult as bringing the pyramids to your middle school classroom.

As in the early days of the Web, to begin implementing AR in your class and courses today requires some programming skills. But the threshold is rapidly reaching a technically astute educator and should be well within reach of most within 18 to 24 months.

Open source- AR Toolworks

The first and most common entry point for Augmented Reality experimentation has been the AR Toolworks Toolkit. This open source software can be downloaded from the Web and after several tutorials, a simple AR experience with a fiducial marker is possible.

AR Toolworks is the most widely available Software Development Kit for Augmented Reality, having been downloaded more than 10,000 times. The software supports all levels of expertise and can become the basis of new applications which "stand alone" and can be installed by a user to run on a Macintosh or Windows personal computer. The system has been adopted by thousands of developers so finding a company to hire to create a learning application for you will not be difficult should you find that your ambitions exceed your programming and 3D design skills.

Currently, the AR Toolworks platform relies entirely on the use of visual recognition and tracking to locate objects in the user's environment and enhance them with still or moving digital data. The platform does not have an AR "browser" so it is not possible to have one application with many different types of learning experiences, as is the case with other platforms.

Platforms for publishing AR "channels" and "layers"

Another option available to create enticing Augmented Reality experiences quickly is to use one of the Web-based platforms that support the creation of dedicated information "channels" or "layers" that then appear in one of the Augmented Reality Browsers available for Android and iPhones.

AR browsers are dedicated applications that detect the user's environment using the GPS and compass, and, optionally, in the case of the junaio browser, some object in the camera's field of view. Then, by matching the situation with digital data, overlays a digital file on the smartphone screen in alignment with the user's focus of attention.

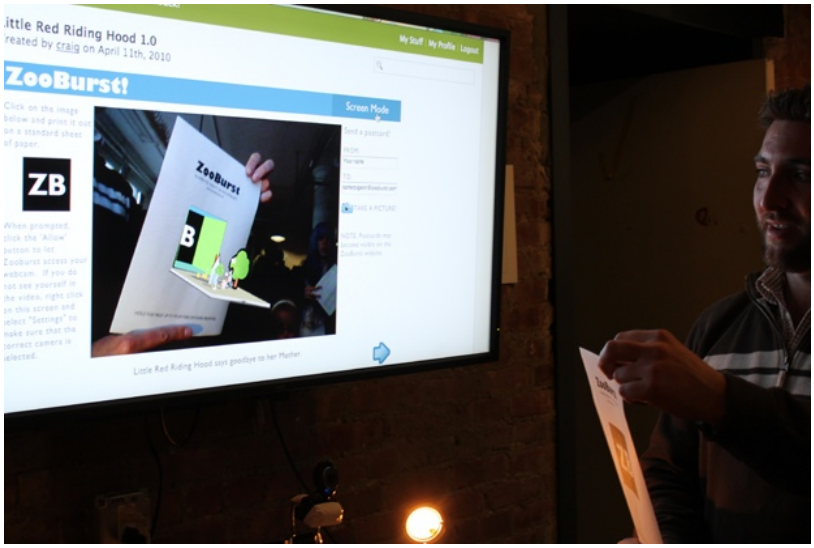
Popular AR browsers are available at no cost on the application stores such as the Android Marketplace and the Apple iTunes Application Store.

To "anchor" digital data to a place, like the Berlin Wall, for example, requires knowing something about the point of interest. Once the relevant "features" are entered in the publishing platform, another file, the enhancement, has to be created and uploaded to a server. Using the content publishing platforms provided by the AR browser vendors, is a multi-step process. Using wizards and tutorials, makes the creation of a custom channel or layer a matter of a few hours to a few days, depending on the number of points of interest, the complexity and the interactivity sought.

The Layar Content Management System and the junaio publishing platform are both available at no cost to developers. Creating a developer account is just a matter of completing an on-line form.

Zooburst

There are also dedicated platforms targeting educators. One such platform is provided by Zooburst, a New York-based start up. The ZooBurst program is, like the platforms of the AR Browsers, all on-line. Already over 750 educational institutions around the world have signed up for accounts to develop their own interactive AR books.



Future trends

Augmented Reality will continue to get more popular in daily life and professional settings, making it a natural extension of the educator's portfolio of approaches to helping learners discover and explore new topics in context and at the most natural levels.

As the number of people familiar with AR creation tools increases, educators will also be able to partner with subject matter experts in various disciplines to bring digital experiences to learners with AR using geospatial as well as objects detected using machine learning and computer vision. The computational requirements of AR are quite high by comparison with other learning tools so the computers on which these applications are installed must be powerful, similar to "game" PCs today. In the future, as the processors available on mainstream computing platforms increase, the needs of AR applications will be in line with the commonly available student computers.

About the author

Christine Perey is an independent consultant and industry evangelist for Augmented Reality services and technologies. She works with companies around the world to develop solutions that will meet the needs of customers in all domains.

She is the founder of several community organizations, such as the Swiss Augmented Reality Meetup Group (ARCH). She is also founder of a community focusing on accelerating the adoption of AR through education and the development of open and interoperable interfaces for technology platforms.

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