

EdTech Mindset

your must-have educational guide to the future

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Virtual Reality promise



**a contemporary
version of**

**"The Emperor's
new clothes" ?**

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The Editorial

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The cover portrays Hans Christian Andersen's tale about an emperor whose convictions define what he sees. Being fooled by false weavers that he is wearing clothes invisible only to the stupid and incompetent, he sees clothes that do not exist.

The metaphor deriving from this tale from the 19th century takes us to today's technological promise of experiencing any fantasy as reality - of tricking our brains to believe that we see, touch, and are experiencing a tailored reality.

On our cover, the emperor's conviction is not triggered by witty swindlers, but by a well-designed virtual reality headset. Danny Zavaro's drawing leads us to reflect about the power of this new technological product currently invading our forums and markets.

For this issue of EdTech Mindset, we invited experts from different fields to provide their perspective of the rapidly growing Virtual Reality trend (expected growth of 2,400% on devices delivery in 2016, according to Int'l Data Corp). Professors, researchers, gamers, entrepreneurs, educators, developers and publishers help us understand the virtues and challenges being offered by the developers of virtual environments. As well as, what impact will this technology have on education and learning in general?

Hoping it will interest you and challenge your convictions,

Dr. L. Cecilia Waismann, Editor



cover image by Danny Zavaro

Virtual Reality and Education:

Five Lessons

that may be Learned

from the Lumière Brothers

It was a chilly evening in January 1896, when a few dozen people, wrapped in winter coats, entered the Grande Café to acquaint themselves with a new medium which would, ultimately, change the way in which the human species would express itself. This new medium, which had actually been demonstrated some months earlier, was the Cinématographe (hence the term, "cinema").



Auguste and Louis Lumiere

Hosting the evening were the brothers Auguste and Louis Lumière, who had worked together in their father's photographic studio, and had struggled to develop this medium over the two years leading up to this screening. One of the

films that they screened was "Arrival of a Train at La Ciotat," which will be remembered as a turning point in the history of cinema.

The exciting first steps leading to the birth of the new medium, the mistaken assumptions made by the developers, the habits developed by viewers, and the surprises that they saw along the way are, from a perspective of 130 years later, fascinating. For those currently involved in the early development of a new medium – virtual reality – it is truly instructive to look at the story of the cinema's first steps, for there are a number of important lessons that can be learned.

1 Why have we stopped running away from the train on the cinema screen?

It may be an apocryphal addition to the events of that evening, but it is said that, as the train approached the station, and gradually filled the screen, the viewers fled from the café, for fear that the train would run them down. There are good reasons to doubt the authenticity of this story, but setting aside the question of whether it actually occurred, it does reflect a fact that is difficult to argue with, and that is that the illusion created on film, in the early days of cinema, was particularly effective. It was easy for us to overlook the gap between the real world and the world on film. Why has that illusion disappeared? Why have we stopped running away from the train on the cinema screen? It would seem that the creation of a realistic experience is something relative, changing – what appeared to us yesterday to be realistic, now appears to be artificial.

The film industry is in a constant race to catch up with the fact that illusions are fast becoming outdated – we have moved from silent movies to the talkies, from black and white to color, from two-dimensional to 3D. The fact that realism is a moving target, rather than a clearly defined goal, also has



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an effect on the realism of the experiences offered by virtual reality platforms. The first generation of experiences, offered three or four years ago, was based on simple graphics and on minimal attention to the movements of our bodies, and yet it still created an effective illusion; even though we felt that we were in an environment that had been drawn or painted, we nonetheless had the feeling that we were constantly falling from the roller coaster, or crashing into the wall in a motorcycle race. The new experiences made available recently, with the release of the updated version of Oculus Rift, offer an environment which is much sharper and more detailed. We can assume that, in coming years, we will continue to experience a constant evolution in the level of the illusion. But when we consider this medium, it is important to remember that, as it develops, so too our stimulus threshold and our expectations from it will also move forward. Those of us who intend to develop virtual reality applications in education have to assume that the experiences that excite us today, will not excite us tomorrow, and that we cannot rely on how VR systems are realized at present.

2 Who wants to see a train arriving at the station?

The whole of the content of the film "Arrival of a Train at La Ciotat," screened on that festive evening, is summarized in its title – the film shows a train approaching, and arriving at the station. It ends with a number of people being seen to get off the train. A present-day viewer would find it difficult to understand what is so interesting about a film with such banal content, one that does not tell a story. Apparently, the interest created among the audience gathered at the Parisian cafe was the "wow effect" – the fact that this is a new medium gets us excited about the medium itself,

and not about what it presents. About two years passed from this screening till the appearance of the first film that told a story, rather than simply demonstrating the capabilities of the medium. It was not the Lumière brothers who made this transition; they stuck to depictions of daily life. Similarly, the present generation of virtual reality experiences in education is a generation that focuses on demonstrating the medium's capabilities. We are still resting on the laurels of the "wow effect." The next challenge is to go beyond that effect, and to tell a story using this new language.



3 Who are the people traveling on the train that is arriving at the station?

The train shown in the Lumière brothers' film was not an ordinary train on a regular journey. For this film, a special train was ordered, and the brothers' family members were the passengers. The intimacy of this film is characteristic of the brothers' other films, including films shot on family holidays and so on. The context of the films made by the Lumière brothers indicates the way in which they viewed this new medium.



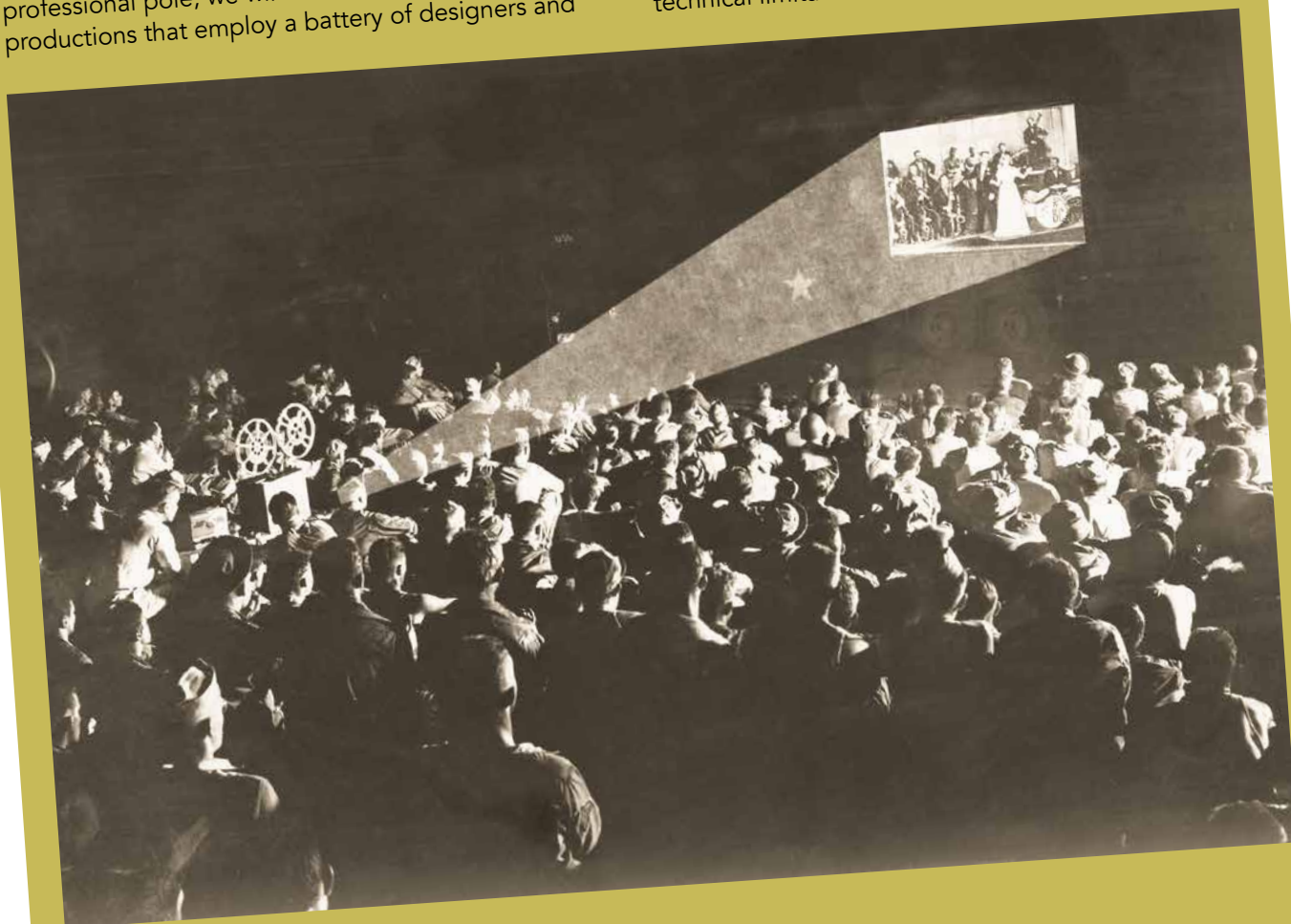
For them, this medium was apparently something amateur, to be used in daily life, rather than a medium for professionals. History has shown that, ultimately, this medium split into two separate tracks: on the one hand, it developed into a professional industry of expensive Hollywood productions; on the other hand it became an amateur technique, whose highpoint has been reached in the fact that every user now has a good quality movie camera built into their telephone.

The first steps being taken by virtual reality indicate that two separate tracks seem to be operating here too – one professional, the other amateur. At the professional pole, we will be witness to expensive productions that employ a battery of designers and

programmers, who promise a perfectly scripted experience. Projections speak of revenues from the virtual reality market of about 30 billion dollars in 2020, with about 80% of this revenue expected to come from content development – films, games and parks. In parallel, some of the significant players in the field, foremost among them Google, are aiming at amateur production of content for virtual reality– starting from 360-degree cameras, through to applications for filming and content conversion. If we were to bet on the area that would be worth developing in the context of the education system – it would seem that the amateur side may have the potential to reach a broader audience and be more effective.

4 Why is the film only a minute long?

The Lumière brothers' projection device had room for a film of about one minute's length. Contrary to what might be assumed, this was not due to technical limitations – it was already possible



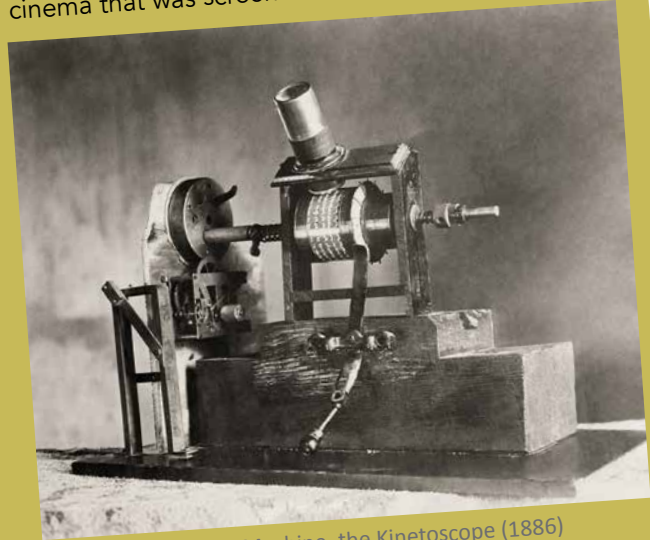
to film and project longer films. The reason for the short length of the film was the assumption that no one would want to watch a longer film. Where does such an assumption come from? It comes from the fact that, when we try to assess the potential of a new medium – of a tool for expression that we did not have previously – we rely on other media that are familiar to us. From the point of view of the Lumière brothers, who made their living from a photographic studio, cinematography was animated photography, and so it was viewed by them as playing the same role that still photography had played till then– taking family pictures, documenting a dramatic moment, recording some important site, and so on. If this is the starting point, there is no reason to assume that there will be a need for films longer than a minute. The cinema underwent a gradual process in which it disconnected from its role of amplifying or extending another medium, and instead took on an identity of its own, with its own language to describe phenomena, such as editing and camera angles, that did not exist, for example, in the theater.

The field of virtual reality is at a similar stage – it is still interpreted as an improved platform for drama, or as an improved platform for the cinema, and not as a medium or as a language that stands on its own. The process of creating a unique, individual identity for a medium is an outcome of its use, of trial and error, and of daily practice. There are no shortcuts in this field; there is no express lane that can be navigated from the theoretician's armchair. If you want to advance this medium so that it becomes an active player in the field of education, you need to close the distance between the medium and day to day life.

5 Why are we talking about the Lumière brothers and not about Edison?

Within the public consciousness, it is the Lumière brothers who are considered the fathers of the cinema, even though other inventors preceded them by some years, among them Thomas Alva Edison. In 1893, two years before the Lumière brothers, Edison created the kinetoscope, another device that allowed films to be recorded and played back.

Why has popular history forgotten Edison, and remembered the Lumière brothers? The answer to this question may lie in the way they chose to implement how the moving picture was to be viewed. The Lumière brothers created a cinema that was screened before an audience,



Edison's First Movie Machine, the Kinetoscope (1886)

a social medium, while Edison designed his viewing experience as an individual one. Edison's kinetoscope was a device that allowed for one viewer at a time. Edison designed it in this way because he did not believe that there would be a business model for public screenings, while such a model would exist for the individual experience. History has shown that, although, at the outset, there may not have been a business model for public screenings, such models developed over time, as a result of the rising popularity of the medium. Demand for this medium was created to a large extent due to the fact that it developed as public medium, and as a social activity.

A new medium and a new language need an audience that will become a partner in its creation, and will speak the new language. Those who are leading the virtual reality revolution are well aware of this aspect. The most telling expression of this lies in the fact that one of the dominant players in the virtual reality revolution is Facebook, which sees this medium as an important part of the interaction of the future in social networks. When we think of virtual reality in education, which is primarily based on dialogue and discourse, this social aspect takes on even greater importance.

Q&A

/ David Wolinsky ///

"It's a new tool,
and we have to decide
how to use it.
Not the other way around"

What is virtual reality bringing to the gaming experience?

→ I think the question is more: "What is gaming bringing to the virtual-reality experience?" Neither of these are really answerable yet because they're both being explored and challenged daily, sometimes bold, and sometimes not at all. But watching people ponder and trek towards where they think the North Star is regardless of how you phrase it is either pregnant with exciting possibilities

or clearly lacking in inventive ideas. As a technology, VR is nothing new. We have seen it attempted before.

What's different this time around is the tech has caught up and it is ushering in an era of eager prognostication.

Those prototypes from the late '80s with hardhats and goggles weren't too far off the mark, but the guts inside have changed exponentially in terms of power. The main limitation is what it's always been: what we can conceive.

These same restrictions hold true for videogames. And for people who have not been following videogames closely, the promise of VR seems to be that it represents some amazing potential in new types of storytelling or unlocking types of games that we couldn't conceive of before. This is a half-truth. While it's true not everyone will be shattering perceptions or blowing our minds -- it would be tiring if that were the case -- videogames are still very entrenched in '80s or '90s types of thinking. Many in big-budget game companies believe we have "discovered all the genres" already, and lots of people



Eve Online Multiplayer game



Los Angeles, USA – Jan. 23, 2016, VRLA Expo

in the game industry see VR as a frontier to port pre-existing games onto another plane of existence. I remember at the first Oculus Connect -- a developer conference to solidify the community for Facebook's platform -- a tech journalist raised his hand and asked the Oculus team whether the controller for their VR headset would resemble a sword or a more traditional gamepad with joysticks and buttons. Earlier today, a VR developer told me she took a survey about types of games people would like to see in VR: one of the choices was "platformer," which is the genre Super Mario Bros. belongs to. The old ideas need to go away if we really want to move forward.

Neither of these are isolated incidents, nor are they necessarily representative of what the developer community in games on the whole are pushing towards. But even without VR, it's the sort of creative lethargy that has been fairly commonplace in the game industry -- excluding pockets of independent developers doing truly crazy and fun and exciting things -- for a long time. However, I do wonder if VR and videogames, if this is something customers actually want or if it's something tech and game companies want people to want because the next consoles they release would essentially just be computers. It's a

mistake to believe a new technology alone can empower us since we still need the human input to take us there. Just how it's not on VR to teach us empathy -- it's up to people "inside" of games and "outside" to come up with something new and meditate on what it means to be creative and make games. By only focusing on graphics for decades, industry games have overlooked that they've been overlooking 50 percent of what it is that makes for digital gaming -- very few refinements in the input or controllers, for example -- VR could be a course correction if they so wanted and that still remains to be seen.

It's a new tool, and we have to decide how to use it. Not the other way around.

Is the gaming industry leading the development of virtual reality?

→ Compared to movies and music, I think so. But that makes sense, because gaming has driven so much of the development and adoption of different technologies through the decades. Solitaire on your computer? ▶

QA



It was largely included to teach you how to use the mouse. I don't know if productivity applications for VR are anything more than hard sells yet to prove it can do more, but I do see things like rap group Run The Jewels pop up on The New York Times with a VR music video or comedian-musician Reggie Watts dive in with bizarre VR experiments. Remember when people like Peter Gabriel and David Bowie were dabbling with CD-ROM? It's the same sort of thing. I suspect what this means is creative people in other genres have long ago realized they are artists in the way many people around videogames are starting to grasp themselves. That is, people who make games don't always have to make "games." They didn't need VR to rethink what they do, but it will hopefully be made clear the magic of VR and "gaming" is not in transplanting familiar experiences over but rather recapturing and expanding on seismic, landmark moments like the first time you moved Mario in 360 degrees in Mario 64 or the first time you moved a paddle in Pong. Games need to get to a place where they're ready to dislodge themselves from thinking they know what "games" even are. And hopefully

as musicians, comedians, filmmakers, and you name it are brought into the fray, cross-pollination and collaboration will lead the development rather than an imagined arms race between different mediums or industries.

They call 2016 the year of VR. Is it a real market boom? Or is it a bubble?

→ I actually haven't heard that! But these sorts of binaries are part of the fun of a new tech or trend: Will it float? I'll just say that I hope if it does float, it's on the strength of people's shoulders and backs

pushing in unison as hard as they can to not take the familiar route we've seen before. Isn't the point of doing something new to do something new? As movies and TV have gone to digital from DVD/BluRay, we've lost access to director commentaries. We should make sure we're not being sold something new while losing something else.

I understand risk aversion, but I think we'd all be pretty disappointed if The Beatles released The White Album on VR and all it was was you sitting in a chair staring at a hifi, staring at your motionless body below you, and wondering why you can't get up even to turn the record over.

It'll be a bubble if all we get is laziness, but honestly it's still premature to even frame it like that. It's interesting tech, and the market right now is still just a tiny set of passionate and skeptical early adopters.

If you're looking to make big money in VR software over the next 12 months, you will be sorely disappointed.



David Wolinsky

independent journalist and the creator and moderator of Don't Die (interview series trying to paint videogames and their industry onto a broader cultural canvas). It and he have a Patreon. He is also a former editor for NBC, The Onion, and has worked on editorial projects with IFC, Comedy Central, and Adult Swim

Virtual Reality for Learning at SxSW Edu

I went to the SxSW Education conference in Austin, Texas and visited the British Museum. While still in Austin, I became immersed in a Syrian refugee camp, and then looked around at the geology of the Australian outback. Then, I had the body of a dog and chased a cat... and the dang cat jumped up on the piano and I couldn't get to it! It can be frustrating to be a dog. Returning to reality, I remembered I was a Learning Scientist and I was looking for insights on what today's newest virtual reality gear might mean for the future of learning.

Avi Washavsky of MindCET (Israel) set the tone at SxSW Edu by asking a packed workshop to consider:

after the "wow!" what comes next?

Yes, virtual reality can be an immediate "wow!" experience. But other, earlier media produced a "wow!" when first introduced to education, too —

film strips, educational film, video discs, CD-ROM, and many other earlier forms of educational media.



Austin, Texas, USA – March 7, 2016, SxSW Edu MindCET VR & Education Summit.

Along with other attendees, I was looking for how VR might make a more enduring impact on learning.

In this regard, a compact presentation by Lizzie Edwards of the British Museum was inspiring. The British Museum wasn't doing the obvious museum thing — she was NOT enabling a user to look at a museum artifact in 3D. As she explained, for people visiting the British Museum in person, there is little value looking at an existing artifact in a headset instead of in display case. ▶



Jeremy Roschelle ///
Executive Director,
Center for Technology in
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► The museum decided to focus on puzzling artifacts; things that are visually intriguing. Why and how people used these objects begs explanation. They placed a few of these objects in an ordinary display case. The goal of the VR component of the exhibit is to engage visitors in generating hypotheses about the objects.

To stimulate visitors' historical creativity, the VR enables visitors to travel back in time - visitors are now able to explore a simulation of a place based on the historical setting in which the puzzling artifact was found. Trained facilitators help the visitors develop their historical thinking. Ms. Edwards shared examples of insights from children and adults about why and how the artifacts in the display cases may have been important in their original settings. Compared to how people typically engage with museum artifacts, some visitors were now moving closer to the practice of historical inquiry about archeological objects.

Here are a few thoughts I had about VR and learning, inspired by my time at SxSW Edu:

1 Learning from the setting, not just a 3D object

I've been unimpressed the learning value of VR experiences that display an object in 3D rather than 2D. In a simulation for physics learning, I don't know how watching a bouncing ball in goggles is better than watching the bouncing ball on a screen — and in many ways, the VR version is more awkward. It seems to me VR has more value when the learner has a meaningful purpose in exploring the setting, taking a role or perspective, or making choices in a realistic wrap-around context. One workshop team discussed a learning goal of "literary appreciation" — could a learner more deeply engage with a close reading of text if they could... explore literary settings in VR? ...see the story through different character's eyes? ...take a role, making choices within character, in a imagined "missing scene" from a novel?



2 Learning transcends the goggles

Across all the different experiences I visited at SxSW Edu, when I saw learning value, I saw an activity that was only partially “in goggles” — effective lessons included mixed elements of discussing, writing, reading, drawing, and the like outside the VR experience. When I “visited” a Syrian Refugee Camp in the session led by Global Nomad’s Group, I was able to use VR to see and hear a refugee child talk about his experience in the camp. This experience was undeniably powerful. But it’s still mostly a passive watching experience. From everything we know in the Learning Sciences, students will learn more when they actively engage with the narrative — and that active engagement is likely to be only partially in the VR goggles. Indeed, the GNG team was emphasizing the broader lesson plans that accompany their VR experiences.

3 Learning principles cross forms of immersion and context

The new low cost goggles are an attention grabber, but as educators we need to focus not on the gear, but on the learning principles. The experience of immersion is powerful. Feeling immersed, however, are not unique to VR. The Connected Worlds exhibit at the NY Hall of Science, for example, immerses students in an ecological world via giant screens in a darkened hall. RoomQuake and other Embedded Phenomena transform an ordinary classroom into a scientific happening. Games, obviously, can also generate a strong feeling of immersion.

Indeed, in the British Museum design, parallel experiences are available on more typical devices. Decades ago, in the videodisc era, “The Adventures of Jasper Woodbury” deeply explored the value of anchoring instruction in contexts and the principles of that research still apply. The newness of goggles should not distract educators from what is known about context-based and immersive learning principles.

4 Learning is social and constructive. VR is not yet.

Lastly, I was paying attention to what the educators in the sessions I attended were dreaming. Their educational creativity often extended beyond what the available demonstrations in two important ways. First, we know learning is a social process and many of the educators were imaging learning experiences that were more fully social than the demonstrations. It seemed to me that the Google Expeditions team was making a good first step to respecting this principle in some of the tools they were providing for orchestrating a coherent classroom experience with Google Cardboard glasses. But there is also the weird social disconnect that I frequently experienced when people next to me donned goggles, and suddenly were social unavailable, lost in some other world and experience that I could not see. Much more work is going to be needed to understand what respecting the idea that learning is social will mean in VR.

(First published at linkedin.com, March 14, 2016)

Virtual Reality

BOON why now?

I believe that there are two main technological phenomena that have definitely changed the course of VR development – the appearance of Oculus Rift and of Google Cardboard. They have both significantly contributed to the current market race of bringing Virtual Reality experiences to everyone! Oculus Rift has taken VR development out of the exclusive labs of universities and R&Ds, and given rise to a new entrepreneurial market among developers and Tech giant companies. Google Cardboard offered a unique opportunity (that took everyone by surprise, including its creators) – VR can be enjoyed by the masses, now.



Google Cardboard

Oculus Rift, a headset that can make dreams come true

Wired's cover in June 2014 portrayed Palmer Luckey (at that time 21 years old), with the following headline: "This kid is about to change gaming, movies, TV, music, design, medicine, sex,

sports, art, travel, social networking, education – and reality. The Oculus Rift is here, and it will blow your mind." A few months earlier, Facebook had bought Oculus for US\$2 billion, and brought together a team of the best of the best (such as John Carmack, video-game legend, as CTO) to create a new social experience. "Imagine sharing not just moments with your friends online, but entire experiences and adventures... One day, we believe this kind of immersive, augmented reality will become a part of daily life for billions of people" (Mark Zuckerberg, FB post, March 25, 2014).

In 2011, Palmer developed, in his parents' garage (garages are apparently the ideal "inventors' nest"!!!!), a rough prototype of a VR goggle that promised a never-before-seen immersive experience. He looked for US\$200,000 of financial support in Kickstarter, and in 24 hours, 9,522 backers pledged US\$2,437,429 to help him work on a developer's kit for the Oculus Rift – "the first truly immersive virtual reality headset for video games." "All of us at Oculus are in awe of the support we've received. Surpassing our goal so substantially in less than 24 hours is very humbling. Thank you!" (Palmer Luckey, Kickstarter, August 2, 2012).

Since then, Oculus has led the development and the promise of VR as the technology that will take us anywhere, without moving, and let us be anyone or anything, without plastic surgery! However, the development has not been smooth. Many technological difficulties have prevented the commercial launch of VR devices. On the other hand, the promise has led to an important boom in content development, especially targeting the gaming world. VR software has been dominant in most technological forums, keeping the market alive and hopeful.



Palmer Luckey, 20, founder, shown at his Irvine office, Oculus Inc., May 24, 2013

The illusion that Palmer Luckey provided to everyone of living our dreams by simply wearing a headset, even if it is for a short moment, has been enough to trigger and maintain a race in the industry towards developing the device that can bring that possibility to the market. The time has apparently come – 2016, with the launch of VR consumer devices led especially by Oculus Rift Consumer Version and HTC Vive.

Google Cardboard made VR accessible to all

In 2014, during its I/O event, Google gave as a present to all members of the audience a very curious product – a do-it-yourself cardboard goggle that used the user's android smartphone to provide a VR experience. That apparently silly-cheap object blew people's minds. With a simple witty design, it provided an experience comparable to that of other very expensive devices, such as Oculus Rift (costing hundreds of dollars plus the support of a much more expensive computer), while Google Cardboard was offered on the market for a few dollars!

This device revolutionized the market not only because it made VR accessible to all, but most of all, it established the market for VR wearables using the user's smartphone instead of being connected to a powerful computer. The strongest contender today is the device released by Samsung's joint venture with Oculus, the Samsung VR Gear.

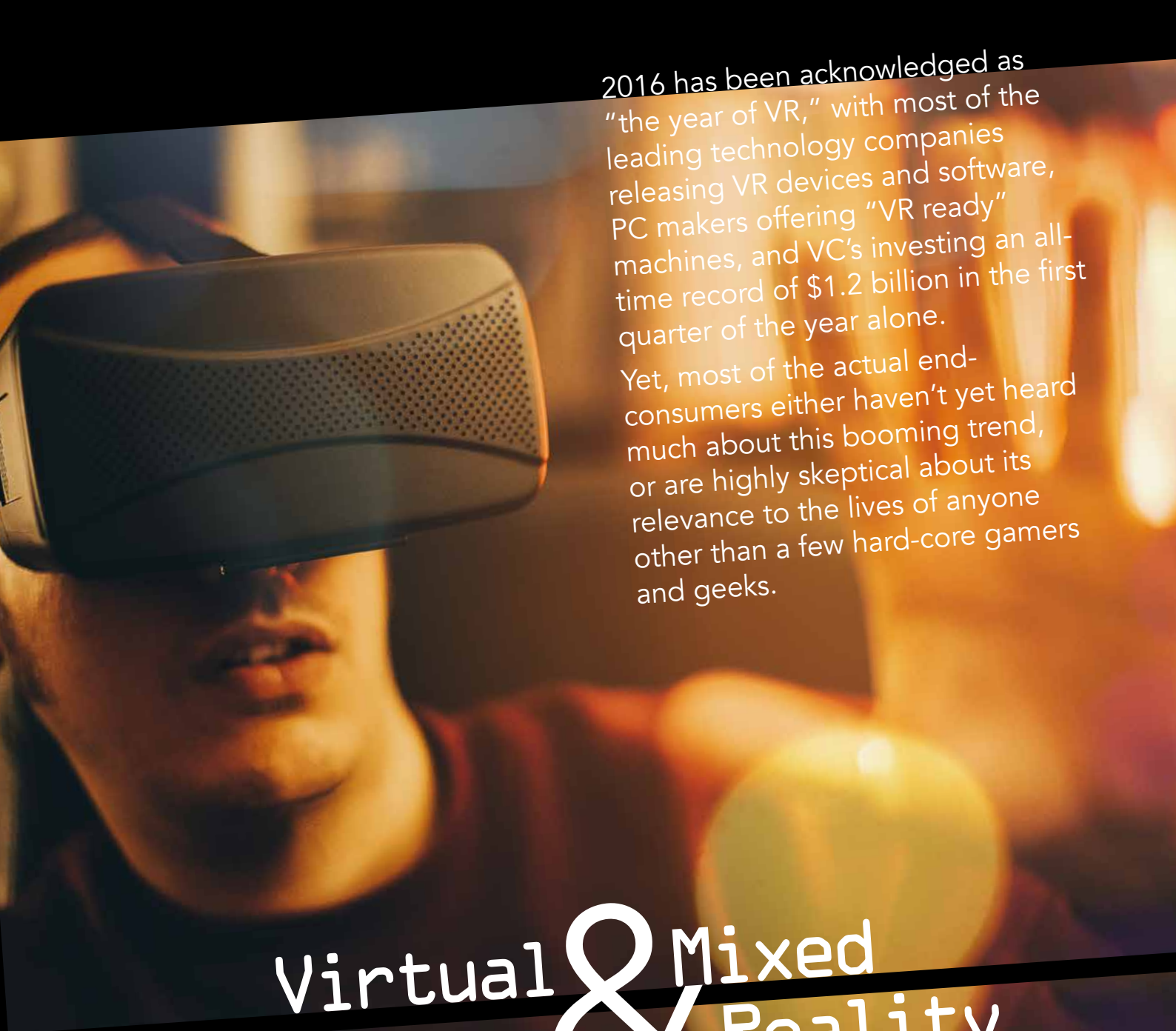
2016: the testing ground for the consumer VR PROMISE

During the last five years, development and promise have guided the VR story. The user's short WOW experience of rolling down a powerful roller coaster ride, of experiencing the body of someone else or of walking on the moon – all without having to move from the user's seat – has strongly overcome the deficiencies deriving from the glitches or the user's feelings of sickness.

The promise that we can BE anything or anywhere, that our glorious dreams can be realistically experienced within a carefully designed virtual world, keep us pushing this technology to become a real possibility!



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2016 has been acknowledged as "the year of VR," with most of the leading technology companies releasing VR devices and software, PC makers offering "VR ready" machines, and VC's investing an all-time record of \$1.2 billion in the first quarter of the year alone.

Yet, most of the actual end-consumers either haven't yet heard much about this booming trend, or are highly skeptical about its relevance to the lives of anyone other than a few hard-core gamers and geeks.

Virtual & Mixed Reality

What You Need to Know and Why It Matters

Even experienced tech developers, including those within the growing Ed-Tech community, aren't still fully aware of the technological nuances and differences between Virtual, Augmented and Mixed Reality, and what kind of experience would best match each technology. Here I shall highlight several key properties of these technologies, based on my own experience with them, and eventually argue that this technological, and apparently also cognitive, speeded evolution, is already inevitably on its way to everyone's homes and schools. In fact, it now seems that most of the skeptics who initially, in the eyes of VR enthusiasts, "just don't get it," indeed reconsider their stance once they actually experience the virtual world firsthand.



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VR & MR: Essentially Similar (Technology), Crucially Different (Experience)

Both the opaque VR headset and the transparent MR glasses generate the illusion of a 3D environment surrounding the person wearing the device, through the combination of two core necessary elements:

1. Stereo Display – presenting a slightly shifted point of view to each eye, hence inducing the convincing 3D experience of volumetric spaces and objects.

2. Head Tracking – instantaneously updating the virtual display according to the user's dynamically changing point of view, hence producing the expected distance-related motion parallax and the illusion of being truly surrounded by the virtual scene.

The resulting experience, however, couldn't be more different. In VR the user teleports into a complete make-believe virtual world, exploring it by looking around, and gradually feeling as truly "being there" inside the computer-generated world, aka the illusion of "presence." In MR, on the contrary, virtual objects are brought into the user's physical world, displayed as 3D holographic overlays realistically interacting with the physical surroundings which are constantly scanned and mapped by the glasses' "room-awareness" sensors to allow (for instance) viewing a virtual ball rolling over the room's physical table.

It's worth mentioning here also the much simpler Augmented Reality (AR), which displays an overlay of 2D flat virtual content over the real world, usually on a phone or a tablet, or through a small monocular transparent display, as in Google's discontinued "Glass" project. AR's main advantage is the availability of the experience on any of the students' existing smartphones, in the form of easily downloadable AR apps. Nevertheless, the actual educational use-cases are very limited, and still rather gimmicky, mainly due to the poor capability of current AR apps to accurately identify and augment specific physical objects using the phone's simple camera. Note, however, that in many of the current media coverage, both AR and MR terms are used interchangeably to describe Mixed Reality devices, and on many occasions AR is now used to denote any AR/MR device which augments a real-world view with a 2D/3D virtual overlay.

Beyond the Buzz – How Can It Be Actually Used for Learning?

As VR and MR induce significantly different experiences, so are their potential uses for learning and education. Since MR's key strength is the virtual-physical coupling, it is best used for overlaying 3D dynamic information (e.g. tooltips floating over a car engine's parts; step-by-step 3D instructions; overlaying pre-captured X-ray images), virtual scientific visualizations (e.g. virtual physics lab combined with real objects; showing biological processes regularly hidden from view) and real-world simulations (e.g. matching virtual 3D models into an existing physical space; fine-tuning physical designs and ergonomics). As MR lets the user transparently view the real world, it also enables naturally collaborating with other students in the class, over a jointly viewed virtual simulation, and easy monitoring of their progress by the teacher (e.g. recording the session, including each student's gaze at any time).

VR, on the other hand, enables the creative generation of any arbitrary experiential world, hence allowing for further far-reaching experiences: teleporting the learner to visit remote places (e.g. through surrounding 360° videos), exploring the miniature (e.g. inside molecules) or the immense (e.g. between galaxies), traveling back in time to take part in historical events, changing time-scales to directly experience any scientific processes (e.g. Einstein's famous beam-riding thought experiment), or even playing with the fundamental rules of physics to explore alternative "what if" questions (e.g. change the speed of light). VR also enables the interesting, and presumably important, experience of having a virtual body (aka embodiment), physically controlled to some extent, which enhances connecting the learned concepts with underlying sensorimotor experiences, as demonstrated nicely in numerous embodied cognition studies.

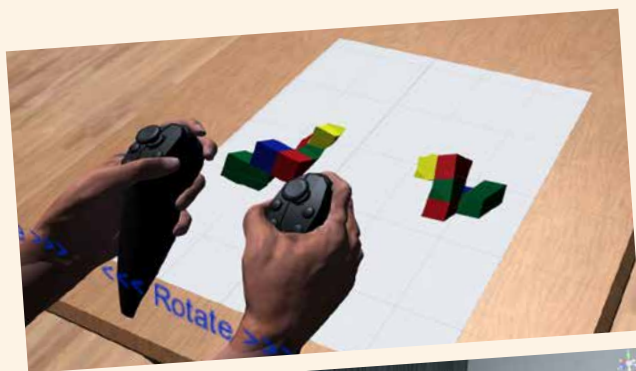
Taking it a step further, identifying with interchanging alternative bodily forms (aka re-embodiment) might enable the experience and learning of completely novel sensorimotor primitives, which may then interestingly underlie the mental generation of novel cognitive patterns and insights. This is indeed part of what we are currently studying in Prof. Reiner's VR.NeuroCog Lab at the Technion.

VR/MR Making It into the Mainstream – The When and the How

We are merely at the outset of the VR era, with each of the currently released devices being sub-optimal in some of its properties – high-end VR devices (e.g. Oculus, HTC) which are too expensive, fully tethered, and complex for consumers to wear and operate; or mobile, simpler and cheaper VR devices (e.g. Samsung, Google), but with lagging display latencies and unbearable VR sickness, also due to their partial head-tracking capabilities (rotational only, not positional). In MR the situation is different, but still premature, with either Microsoft's HoloLens, which is a high-end all-in-one device (untethered, "inside-out" positional tracking), but priced at \$3,000 and with a rather small field of view; or Meta's huge-field-of-view glasses, but with otherwise low-end display and tracking technologies and a fully-tethered device. Either way, it will take only a few more years until the next generation makes its way into the consumer market mainstream with a more balanced combination of cost and minimally necessary specs (e.g. Google has just debuted their "Daydream" future mobile VR device which aims to hit exactly this sweet spot soon).

Even after releasing well-balanced devices to consumers, probably within the next 2-4 years, two crucial additions are needed in order to make the man on the street (or the student in the class) put these weird and clunky headsets regularly on their eyes – those missing elements are social interaction and haptics:

> **Social Interaction** – Virtual Reality is currently a very lonely place, and VR users become even more solitary due to the opaque headset disconnecting and alienating them from their physical and social surroundings while using it. VR will become a mainstream platform for regular (i.e. also non-geeky) people, only when VR apps will in fact be virtual "places" populated with many other VR users to meet and interact with (through natural voice and basic head motions at first). This will also make people much more dependent on their VR devices, as friends and family will physically "wait" to meet them in certain VR places, at certain times, much in the same way that we almost obsessively



Technion virtual lab: VR cognitive experiments

probe our WhatsApp to make sure no one important to us is awaiting our response. Facebook have understood this expected VR addictive dynamics very well, and therefore acquired Oculus Rift VR (right after acquiring WhatsApp as well), with the aim of transforming current Facebook social groups into the future's VR places. There is still an unsolved technological challenge of how to track and realistically visualize the VR user's full body (and the face, while occluded with the headset), in order to realistically represent the user's avatar and its motions in the virtual world. However, this is in fact not a deal-breaker, since the important factor would be merely knowing that the person represented by the symbolic and non-realistic (e.g. blocky Minecraft-like) character is your mother, waiting for you to answer her "call" and come to meet her there. The medium's realism is not as important as some may still think. This is quite similar to the situation in the early days of the telephone (late 19th century) – when the message being transmitted and reproduced as a rather metallic voice didn't change the clear knowledge that it's your mother on the other end of the line, and what mattered was what she said, her choice of words, and her intonation, even when it definitely didn't sound like her voice. The medium becomes invisible when it transmits well the most important and meaningful information of the interaction.

> **Haptics** – The addition of the ability to touch and feel virtual objects as having physical properties is not a must-have element for the basic VR experience, but would nevertheless experientially (and historically) mark the line of

distinguishability between the virtual and the real worlds. To illustrate why this particular sense of touch, rather than any of the other human senses, is so important to "realism," consider what you might say in each of the following scenarios: 1. You reach to grasp a seemingly physical object and your hand surprisingly flows freely right through it – "apparently it's just virtual, but it looks so real"; vs. 2. You move your hand quickly to go right through a seemingly virtual object and your hand surprisingly bumps into it – "apparently it's real, but it looks so virtual." It is the haptic interaction with the object, and its relevance to our bodily operation in the world, which makes it unquestionably become "real" to us (and then the question "is VR real?" suddenly sounds much more uncertain and philosophical). Moreover, when an environment's objects, even only a few of them, are directly experienced through touch as rigid and "real," all the other objects at once, even those not within reach, are then cognitively considered real as well (until proven otherwise). These virtual objects are thus perceived by your brain as having all the physical properties, and – most importantly – all the functional affordances, of real objects, which completely transforms the global perception of yourself and your body within this seemingly virtual world.

VR/MR and Education – What Does the Future Hold?

As much as the aforementioned educational uses of VR and MR sound futuristic and uncertain, these are in fact the first generation of VR learning experiences, characterized by letting people use their existing cognitive capacities within VR, similar to using the same capacities in the real world. The next phase would include being virtually re-embodied in various different bodily forms, and thus re-learning novel sensorimotor patterns (like an infant, from scratch), in order to adapt to the new body-world setup. As our cognition (even our abstract or mathematical thought) is now believed to be much more "embodied" than previously believed, i.e. based on our learned bodily interactions, these re-embodiments would also induce dramatic modification of our cognitive patterns and inferential structures. Consider, for example, the case of human logical intuition, which is also based on learned physical interactions – can sense and nonsense somehow get mixed in VR's wonderland following twisted sensorimotor experiences?

TIPS for VR development and minimizing VR sickness:

1 Let the user control her motion, preferably in a way that allows the user to predict her resulting speed and trajectory (e.g. linearly translating the controller's stick motion to velocity).

2 Never forcefully move the user's virtual point of view! Only her own controlled motion should affect it (but see the following "top-down context" tip for exceptions).

3 Top-down context, e.g. the scene's narrative, matters significantly – use it wisely to match the character's movements; e.g. smooth motion controlled with the stick makes more sense when seated in a virtual cockpit than when walking upright or climbing stairs.

4 Make the character's motion as slow and gentle as possible, avoid unnaturally sharp turns, and be especially careful with fast height changes.

5 Focus less on the velocity and more on the velocity changes – it's the accelerations which the brain expects to physically experience (recall Newton's second law...).

6 Display a virtual body, even a static one, as it greatly contributes to the realism. Users may sometimes even unconsciously match their pose to the virtual one in order to increase the effect.

7 Use first-person perspective (1PP) when possible (i.e. instead of viewing the body from outside) – shown to play a major role in inducing immersion and realistic embodiment. But if the player is moved forcefully in the scene (breaking rules 1-2 above), then avoid 1PP and use a disembodied point of view instead (e.g. from a static top-view floating camera).

8 Multi-sensory feedback can't be overrated – the effect is super-additive in nature: perceiving a matching visual-auditory (or visuo-tactile) event further amplifies both the visual and auditory (or tactile) perceptions of it. Use as many synchronized modalities as possible.

9 Don't re-invent the wheel – the VR community (e.g. Unity) is growing fast, and many have already tried to do what you're up to. Use available VR assets, and reuse software modules from other developers whenever possible.



Microsoft HOLOLENS



As a more radical thought, consider our ongoing mental inner dialogue, which is based on the same (learned) language which we use to communicate with others in the world – how this might change when 3D objects and physical structures would be easily generated through quick bodily gestures in VR, much faster than describing these new “ideas” in words – will it possibly create a new communication language, which may also modify our “language of thought”??

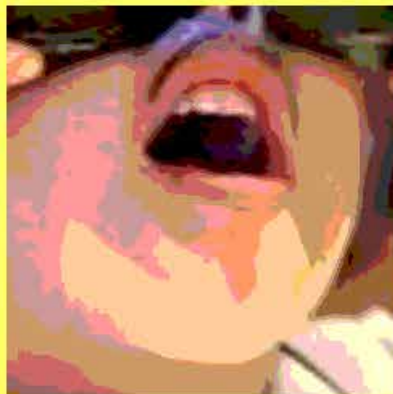
When zooming out to a more historical perspective, we are on the verge of a human cognitive shift entirely driven by these new “experiential” technologies. Unlike in prior similar-scale disruptions, which required evolutionary time-scales to realize their impact, such as the prehistoric dawn of stone tools (the first body-extension technology!), this time we will probably live to experience all the fascinating stages of this evolutionary leap. It remains to be seen how such VR-cognition would transfer back into the physical reality, and even more intriguingly, what new ideas and inventions it may bring about, which will also form the subsequent stages of this truly unpredictable virtual revolution.

For further reading – keywords to Google for, combined with “virtual/augmented/mixed reality”: “oculus rift,” “hololens,” “htc vive,” “magic leap,” “meta,” “gear vr,” “daydream,” “void,” “tele-learning,” “embodied cognition,” “motion/vr sickness,” “positional/rotational tracking,” “presence,” “room awareness,” “out of body experience,” “virtual hand illusion,” “body extensions,” “haptics,” “redirected walking,” “redirected touch,” “extended mind,” “rehabilitation,” “temporal recalibration,” “multi-sensory integration,” “brain adaptation,” “peripersonal space,” ...

VR Sickness and How to Avoid Undesired “Learning Sickness”...

As VR generates a more complete immersion than AR/MR, it is also much more prone to unpleasant feelings of “VR sickness,” including dizziness, headaches and nausea. These physiological symptoms quickly arise whenever the virtual display isn’t updating quickly enough (in the order of 10 milliseconds) or is not in perfect sync with the head’s changing position and angle and the brain’s sensorimotor (and vestibular) predicted expectations. Moreover, the learner’s brain quickly couples such physiological aversion with the concurrently running experience (e.g. VR learning app), resulting in a strong aversive conditioning, inducing immediate sickness whenever encountering similar learning experiences – the complete opposite to any desired educational outcome! Therefore, it is crucial to validate any planned VR learning experience as fully “sickness-proof” before letting students even try it once (see more on how to minimize sickness in the “few tips for VR development” frame).

With MR, however, the brain takes the seen physical world as its “anchor.” Hence any visual imperfection is attributed mainly to the virtual objects – experiencing them, rather than the world, as jittering or drifting over the physically stable world, and thus inducing much less “MR sickness.” This is currently still a huge advantage of MR over VR as a viable tool for daily usage, at least until VR experiences finally become truly sickness-free for all the users at all times.



The VR gape

Danny Zavaro



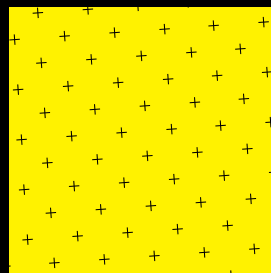
Danny Zavaro ///
Creative Director
Innovative Development Unit - CET,
Centre for Education Technology,
MA in Digital Moving Image,
London Metropolitan University

VR,

AR

OR

MR



[[VR&TECHNOLOGY]]



Ofer Tiber

Head of Innovative Development
and previous CTO of the Center
for Education Technology in Israel

We are all too familiar with a chart comparing the revenue share of AR and VR in 2020, predicting a big lead of AR over VR.

This choice of contrasting AR and VR represents the current stage of dichotomy between the two, which is a result of temporary technical limitations – requiring a different device for each experience. This dichotomy will lose ground as technology evolves (eventually reaching a direct brain sensory feed).

Wikipedia in its article Reality–Virtuality continuum (RVC) portrays a continuous scale ranging between the completely virtual – a virtuality, and the completely real – reality. In other words, detaching the user from reality (VR) and mixing virtual and real elements (MR) are both part of the same RVC range. The dichotomous way of thinking hinders the development of the medium as a potential expressive art form.

Eventually technology will enable the convergence of the entire RVC, in smooth transitions, allowing a unified rich experience. MR and VR will be mere nicknames of expression tools used seamlessly in the hands of the RVC réalisateur.



Todd Revolt

Director Strategic Alliances -
META Company

"Education will be enhanced in VR or AR in different ways. VR, which fully immerses you in a different "virtual" reality, will be great for learning that fully surrounds or transports you, such as touring the Coliseum, studying jungle flora, etc. By contrast, AR (or what some call MR) blends digital information with your surrounding environment. For most classroom or workspace needs, AR will be the proper solution because – to some degree – you will need to interact with the real-world around you. This is superior for education where you may need to communicate or collaborate with others — literally "looking them in the eye" — across the table or across long distances."

Experience, Immersion and Critical Distance: VR/AR in Education

It's a truism to say that we learn through experience, but it seems that each generation must reinvent the wisdom and significance of this key idea in education. Today we talk about presence — the ability to transport the viewer into another world. This is arguably the real appeal of VR/AR.

Throughout history, we've always learned best by being metaphorically transported through interacting with the storytellers of our culture, around the community campfire. Today, games, film and visual media provide forms of storytelling that may function as mediated experiential learning, where through a combination of images, sound, music and interactivity, people feel engaged with characters and situations, and making decisions, taking action, and analyzing and solving problems. George Gerbner, a media scholar and educational leader at the University of Pennsylvania once considered mass media to be the central educational institution of the culture. By skillfully combining entertainment and information, learners are invited to empathize with the protagonists of movies and TV shows and feel connected to their experiences, applying the lessons of the protagonist's experience to their own lives.

Today, educational technology continues to enable educators to tap into the complex power of media for active learning. As we notice how this generation is unresponsive to lecturing, we're now seeing teachers create learning environments that require their students to access, analyze, create, reflect and take action, using a variety of print, visual, sound and digital texts, tools and technologies.

As part of a dynamic paradigm shift in education, educators are now recognizing the full potential of educational technology to transform sit-and-listen pedagogies of traditional education's transmission model with both the try-and-explore pedagogies of gaming and the create-to-learn pedagogies of digital media.



Prof. Renee Hobbs exploring META, an AR device

By combining the features of gaming and digital media to support learning, VR/AR offers us a 21st century return to Dewey's dream of learners immersed in real world actions, learning from experience and reflection on action. After all, if transformative learning experiences are what enable people to reach their full human potential, VR/AR may stimulate new appreciation for restoring immediacy and intimacy to experiential learning, in its mediated and interactive form.



Renee Hobbs ///
Professor in the Harrington School
of Communication and Media
at the University of Rhode Island,
Director of the Media Education Lab

Immersion vs Critical Distance

Of course, wearing a VR/AR headset and exploring a virtual world is not the same as real-world experience. The VR/AR experience has been carefully crated and constructed. All media are constructed, and VR/AR is no different. When a student uses the New York Times virtual reality journalism app to explore "The Displaced," which depicts a Syrian refugee camp in Lebanon, he or she feels a sense of being there, but this illusion has been produced at great expense by a team of photojournalists, editors and computer programmers. Immersion just doesn't happen: it's produced.

Unlike the filmmaker or photojournalist who can simply record action at the scene, the virtual-reality filmmaker must involve the subject in an elaborate choreography of action to create the illusion of immersion. A subject may be asked to repeat an action, the scene may be staged or arranged to meet the needs of the 360o film equipment. The intense visual simulation of these powerful illusions may interfere with efforts to craft balanced and fair narratives. The deep immersion that VR/AR provides may interfere with recognizing that media are selective and incomplete and always represent a particular point of view.

And even more troubling, given that people's understanding of reality is shaped by Hollywood, Madison Avenue and Silicon Valley, it may be that VR/AR inevitably achieves its sense of "realism" by approximating the realities represented in advertising and propaganda, action adventure movies and first-person shooter games. Media scholars have long recognized that people may see mediated "reality" as more real than their own lived experience. After all, this is what leads many people to represent themselves as celebrities of a sort on social media.

The rise of VR/AR in educational technology may offer the potential to bring educational technology in a closer relationship with the fields of perceptual psychology, communication and media, and cultural studies. This is an important goal.

As educators use VR/AR technologies for learning, they will be compelled to also provide their students with an understanding of how VR/AR works. By helping students to critically analyze and deconstruct virtual reality, they discuss how and why the illusion of presence is sustained. This, then, changes the way we use the media.

A pessimist might argue that VR/AR is just another way to restore the power to large technology and media companies towards more control over the content of the curriculum. One can easily imagine a state-of-the-art virtual reality app, as expensively produced as a videogame and underwritten by an oil company, taking students into the aftermath of an oil spill and offering us a great science lesson with a powerful and immersive illusion that showcases the company's efforts to be a good corporate citizen. Such efforts are misguided forms of propaganda that will not improve education.

But nearly from the moment they experience it, students and teachers alike always ask, "How can I create a virtual reality experience myself?" An optimist might recognize that, instead of positioning educators and students as the simply the receivers of education technology products, the rise of VR/AR may align with the power of create-to-learn pedagogies and embrace our capacity to be content creators.



Prof. Renee Hobbs, teachers and developers,
collaborating to develop an AR educational solution

Learners now expect to "talk back" to media and this expectation should shape the future of VR/AR. I imagine a future where VR/AR in education helps learner and teachers represent our unique and subjective lived experiences to one another in ways that build our capacity to gain knowledge, embrace ambiguity and respect cultural diversity, and better care for the lives of others.

When will VR become a social space in which we can learn ?



The Islands. Collaborative virtual space by Keren Elimelech, high school teacher

Second Life is the leader of compelling, cost-effective virtual education solutions to amplify an existing curriculum or create new models for engaged, collaborative learning.

Thus begins the page touting Second Life as an educational tool.

Remember Second Life? If not then you probably weren't paying attention in 2005–2006. The media were full of hype about this 3D world that anyone could enter via an avatar, and that anyone could build in. People put in many hours creating fantastic structures that ranged from floating homes to complete resort hotels to a faithful representation of the Matterhorn.

Educators flocked to the space as well. Hundreds of them built classrooms and open spaces in which to hold at-distance classes. People used Second Life to create online galleries and museums and to build complex representations of machines or bodily organs. I'm sure some of those activities were successful. But it was hard to do.

Harvard's Berkman Center for Internet & Society, where I was and am a researcher, constructed one of the earlier experiments: a version of a classical Greek forum with stone benches facing a large video display that showed the live Web feed from the weekly lunch-time talk.

But why enter Second Life to watch the feed when you could just open up a browser? After all, Second Life required installing special client software, it was laggy, and its graphics didn't even measure up to the quality of the video games of that time. Even so, in the real-world seminar room some attendees would have their laptops open, participating in the Berkman Second Life space along with people attending remotely. I was sometimes one of those people.

The reason was simple: In Second Life you could talk to people – via text balloons – near you in the space. Second Life served as an elaborate, graphical backchannel. Now we'd probably do it with Twitter, but Second Life had some advantages. The channel only contained people in the virtual room, so you weren't generating noise for the rest of the people who follow you. If you wanted to talk with someone else, you just walked over to their avatar. And because talking with someone was like texting them, it was easier to create a conversational thread than by using Twitter.



David Weinberger ///
Writer of the effect of technology
on ideas.
Senior researcher at Harvard's
Berkman Center for
Internet & Society

This ability to selectively chat with someone about an event you both were watching was unique at the time, and made it well suited for some types of educational experiences. Unfortunately, its social affordances were rather meager, and using them required committing to an unwieldy piece of software that was never particularly easy to use.

Now virtual reality has arrived, holding great promise for immersing students in simulations from which they can learn. The quality of the VR graphics in this first round is already considerably higher than Second Life's was back in the day. That's important because bad graphics hurts immersion.

But will VR become a social space in which we can learn? Perhaps more exactly, when will it become a social space, and what type of sociality might it support?

The cost of a VR headset, especially if one includes the cost of a PC powerful enough to support it, is prohibitive for classroom use and is likely to stay so for quite a while; the expensive components are not on the same sort of price curve as hard drives have been. So it's hard to imagine that any time soon the students in a classroom will simultaneously don headsets and explore some virtual space together.

But it is not hard to imagine that individual students will be able to interact with other students from around the world as they explore a shared virtual environment. For this, designers could learn some lessons from Second Life. For example, it was not uncommon in Second Life to find yourself talking with a butterfly, an alien, or a floating squiggle. The ability to decide how to represent yourself introduces a distance between you and your online presentation that can ease some of the social friction. It can also enable harassment and bullying, which systems will of course always have to be prepared to deal with.

It is even easier to imagine adult learners putting on a VR headset they bought to play games with (no matter what excuse they gave their spouse) and visiting a virtual environment to learn and explore. When there, they well might want to talk with others, if those others are represented in the virtual space.

But there's another lesson of Second Life: It is hard to know how people want to socialize with others, especially in a novel environment. It's not the case

that we all always want the most complete sensory experience possible. For example, for a high percentage of the Skype calls I participate in, the people involved choose not to turn on video. Video inhibits them and can inhibit conversations. In fact, Slack is becoming a very successful company and a highly valued tool because it has created an implementation of text chat useful in office environments. Text is so 2500 BCE, yet we still find it preferable in many situations.

So in what conditions will we find it helpful and comfortable to socially engage with other occupants of an educational VR space? It's impossible to predict. Perhaps an app that simulates an art museum will station docents at various spots – real people that visitors can talk with. Or perhaps some educational VR scenes will recognize the importance of social objects – objects that facilitate conversations among strangers. For example, perhaps a virtual space will give people tools to craft shapes and then to output to a 3D printer; one can imagine a visitor approaching someone working on a complex project and asking how she does it. Or, perhaps in an exhibition gallery visitors will be able to leave comments next to paintings to stimulate conversation with other visitors. (Presumably those comments vanish when the visitor leaves the simulation.)



The Islands.

We can't know what will encourage and facilitate useful conversations among people inhabiting a shared VR space because the medium is too new. But virtual spaces will be filled with others; VR games insure that. Anything else would be too lonely a vision and too perfect an incarnation of solipsism. And once people are occupying a space together, it won't take much for them to start learning from one another.

Q&A

/ Vincent Fung ///

"The pace of adoption of VR technology in China is faster than in many developed countries"

How do you see this "VR market boom" and what effects can it have on the educational market?

→ Virtual Reality (VR) technology is a revolutionary new media, just like the first time humans were introduced to books, magazines, radio, or television, which greatly changed the mode of transmission and consumption of information. VR is immersive, as you can see it, hear it, touch it, smell it, and feel it.

You may ask: are we exaggerating the impact of VR as we did with 3D printing a few years ago? I think every new technology has its hype cycle. But this time VR is very different. It has a much wider influence on many industries, starting with gaming, media, and edutainment. Even more so in the education market, since the dissemination of knowledge is the core of this industry which will certainly be affected significantly. It's possible that we will advance into cross-reality, 4D, 6D environments at home or in schools within the next 10 years.

How do you see VR development in relation to China's educational market?

→ The pace of adoption, and especially commercialization, of VR technology in China is faster than in many developed countries. For example, this year we (NetDragon) have leveraged years of our 3D gaming experience to develop and bring VR solutions (including one of the largest 3D and VR content libraries) into schools in China. So far, we've received a strong welcome from many schools.





There are also many big companies that want to partner with us to boost the VR development in this educational market.

How do you foresee the scalability of VR in the Chinese market?

→ The first Apple iPhone came into the world almost 10 years ago and sold for \$699+. Now you can buy a new, high quality, high storage smartphone for under US\$200 only. By contrast, the cost of VR hardware has already gone down significantly since 2013. We believe the adoption of VR will be faster than any smartphones, to be used not only in education but in many other industries, such as corporate training, real estate, home design, virtual tourism, entertainment, and so on.

I think the priority now is to create enough high quality and engaging content to keep up the promise and meet the demand of the users.

Will the “accessibility” to Virtual Reality devices affect current pedagogical practices?

→ It will help promote more personalized and blended learning. Not every household can afford a headset per family member in China but schools in China are more willing to invest in VR to transform traditional classroom learning into a

more digital, immersive, and interactive experience. The governments are also very supportive of this movement. Therefore,

I think the speed and popularization rate of VR adoption in schools will be faster than the rate of adoption of personal computers.

VR, AR, or MR? How do you see the future of these technologies?

→ These technologies are still in an early developmental phase. AR is 2 years out; MR is more than 5. But there are already real use cases, products, and content available for education, media, entertainment, etc. I believe that in the near future, with the improvement of technology and people’s increasing reliance on these kinds of technological products, we will enter the next information era.



Vincent Fung

Investment Director at NetDragon Websoft Inc., focusing on corporate strategy, leading and executing transactions – such as the acquisition of Promethean World – as well as negotiating strategic partnerships.

Enabling anyone to create VR & AR content for education

Why Virtual Reality Holds the Key to Education

As Augmented and Virtual Reality technologies mature, they present a unique opportunity to change the face of education as we know it. AR has been used in education for several years now. To date, it has added simple capabilities like inserting a video into a textbook. Imagine a child flipping through a WWII history textbook to a page with a picture of Winston Churchill giving his famous 1941 speech to Congress. A video of the speech then appears as if it were on the page of the book itself.

Content Creation – The Next Frontier

Imagine how much knowledge could be created in AR, VR, and Mixed Reality (MR) if the ability to create content was easy and fast for anyone to share. For hundreds of years, content was the domain of centralized hubs, either human (experts, clergymen, leaders) or physical (libraries). The internet decentralized and democratized knowledge and content. With Wikipedia, millions of people form and share information and knowledge. But for several years content was still restricted to one place – an actual, connected computer.

Over the last few years, mobile phones have brought content creation everywhere. The next phase is AR/VR – experts, teachers, and students will be able to create and share content to devices everywhere. Wikipedia is still restricted to the internet – and not the real world – but imagine taking all this knowledge and implementing it in the real world.

We are on the verge of a huge evolution; soon anyone will be able to create content, share knowledge, and bring it anywhere in an intuitive way for others to enjoy it. You can look at a street sign and see content created by your neighbor (or by a complete stranger thousands of miles away); you will know the names of the flowers just by

looking at them, or the ingredients of your food; bring back to life a historic monument in your town, then share it with everyone. Show and tell will never be boring...

This is a huge opportunity for this medium to grow exponentially, but the ability to create content in this new advanced technology was reserved to experienced engineers only. This is why companies like WakingApp created a free, easy to use tool that allows anyone to create content. A poster of the human body (or a 3D human anatomy model, for that matter) can have a whole layer of interactivity – video, sounds, pictures -through an AR device. But that just scratches the surface. AR can add advanced interactivity in the form of quizzes, puzzles, games, events activated by your actions, connecting to the web, and collecting data about student performance. In essence, you can take all the abilities that exist online and place them in the real world, not just in the classroom with books and posters, but outside the classroom too; on a class trip to a famous battleground, for example, a reenactment of the battle can bring the site to life, depending on where you gaze or point with your AR device.

While AR delivers digital content to the real world, VR places the student in a completely different virtual environment. The benefit of VR is that it's unlimited – instead of venturing to the battleground on a six-hour bus ride, you can experience it virtually from a remote location, and feel like you're a part of it.

Reading about the Civil War may be interesting; watching a movie about it is certainly more immersive; but the most sensory way to learn about the war would have to be a virtual tour of the battlegrounds of Gettysburg (VR) and/or to walk through the actual battleground while interacting with Northern and Southern soldier characters (AR).

VR can increase the realism, amount of information, and details students perceive. You can allow students to select exactly what they want to see. A movie of Gettysburg, for example, 'forces' students to experience the battle through a predefined framing chosen by the director. By contrast, even a 360 movie (a linear version of VR content) allows students to look and see what interests them. According to education research, just having the ability to make such decisions increases engagement, and increases the likelihood of repeat engagement.





Alon Melchner ///
Wakingapp Founder & President,
Head of Strategic Vision
& Technology

Add interactivity to the mix – the ability to touch or talk to another soldier, shoot a rifle, review and tweak the strategy on a map – and you have an unlimited world of possibilities. While some educators may be wary of losing control over the message, a wise creator of VR experiences can predict what actions students may be interested in, and connect the most valuable data, information, and experiences to those actions. Imagine teaching about the birth of a child – you can show the inside of the womb, stages of growth, or allow users to rotate the embryo to understand what organs are developed at what stage of pregnancy. Or imagine VR simulators, allowing students to learn how to drive a car, step-by-step, with maximum realism and minimum danger.

The Classroom of the Future

The foundations for the classroom of tomorrow are the physical network and the visual components. The first consists of billions of sensors, appliances, wearable devices, and computers that are already connecting to form the Internet of Things, with an added layer of Big Data analysis, and to extract meaningful insights out of the endless bites of information. The visual layer of the classroom of tomorrow is a combination of AR, VR, and MR.

Dissecting a real frog in biology class will soon be a thing of the past. Already today, VR can replace the experience quite well. But in a few years, holographic possibilities will be added to the experience. Maybe it will be achieved through a wearable device like glasses or contact lens, or perhaps by miniature projectors, but there will certainly be no TV or computer screens. Students will see what they want to see, dissecting the virtual frog, removing organ by organ, as if it were real, and sharing the experience, as they wish, with other students or the teacher.

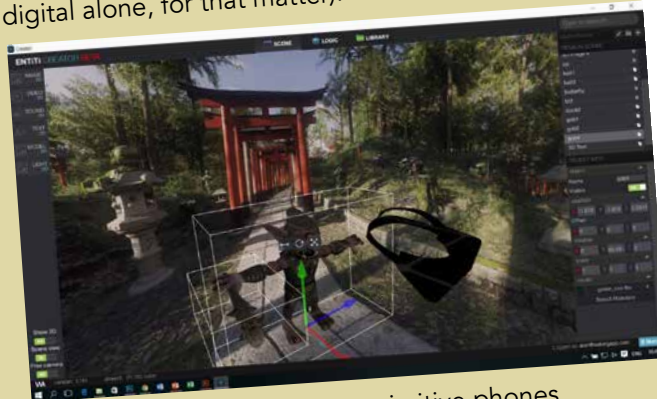
Where Does This Leave the Physical Classroom and Teacher?

Cameras are nice, but AR and VR allow teachers and students to fully interact and engage remotely. 360 cameras can offer students the freedom to view, hear, and maybe later interact with the environment. You can be sick at home but view the classroom from your seat. Perhaps the whole classroom will function like this – one camera and unlimited students. Alternatively, there may not be a classroom at all. A real teacher or an avatar can teach an unlimited number of remote students.

What's left to be seen is who will create all of the VR content. Creating one textbook or three movies per lesson is easy. How do you create thousands of possible outcomes for each decision a student might make? Yet to be seen.

But printing will not disappear. You can print posters, but you can also print plastic, paper, food, pieces of a frog. 3D printers will play a major role in the future classrooms in the coming years, and this will help create a mixed reality.

It's worth pausing and considering what MR will do to the learning experience. Why learn about plants in a book or on a 2D screen? You can see a 3D item (say a 3D printed plant), and the layer of AR content will explain to you what you're looking at. Digital content will be part of our real lives. Everyone will view the world through two layers – the real and the digital – and both will be meshed together. It will be hard to imagine how students learned through offline experiences alone (or digital alone, for that matter).



In museums there will be no primitive phones playing audio about each painting. You'll experience everything visually, through imagine, video, audio. You will interact with the painting and the painter, and even observe the stages of how it was painted, and try to replicate techniques such as cubism or pointillism yourself.

The Effect

How will MR affect us psychologically and socially? Our processing capabilities will grow stronger. People will be immersed between real and not real. There will be a question of what is real. If there is a fake hologram you created moments ago but you can feel it, why is that not real? Think of the Magic School Bus – a teacher can transport the whole class to a safari in Kenya or to Planet Mars.

Time and space will no longer present a limit. The Holodeck in Star Trek will no longer be science fiction. In 5-10 years, that's how students will learn about the world.

The technology exists already. We need to improve the hardware, get the right devices, and make lots of content. Most importantly, we need visionaries in education who are ready to take the next leap and take education to a whole new level.



ENHANCING environmental & cultural AWARENESS through VR video games

Since 2013, the Learning Experiences Innovation Laboratory (LINNEA), a joint venture between Cengage Learning – National Geographic Learning and the University of Chihuahua, Mexico, has been exploring the use of VR games as tools for engaging users in learning experiences related to natural and cultural conservation.

The first product in this line of research and development, an Oculus Rift video game called “Reto Holtún” (Holtun Challenge), was developed in collaboration with Guillermo De Anda, Mexico’s first and only National Geographic explorer, who helped to recreate Holtún, a sacred underwater cave located in the Mayan rainforest, currently open only for research purposes.



Fernando Ledezma ///
Head of the Learning Innovation Laboratory
(University of Chihuahua, Mexico);
specialized on the development
of technology-mediated learning experiences,
with focus on virtual and augmented reality

The game, created by an disciplinary-overlapping team of software programmers, 3D modelers, interface designers, and video, communication and learning specialists, allows the user to virtually dive in the cenote (the local name for underwater caves), with the task of collecting (with the help of the Leapmotion motion sensor) objects that refer to real findings from multiple De Anda expeditions.

The experience of developing a VR game with learning purposes has led LINNEA specialists to diverse findings regarding user experience and interface design, ergonomics, translating gestures from real to virtual spaces, workflow modeling, and how to effectively and subtly embed learning microtasks into the narrative of a true gaming adventure, targeted to users ranging from as young as eight years old to adult age.

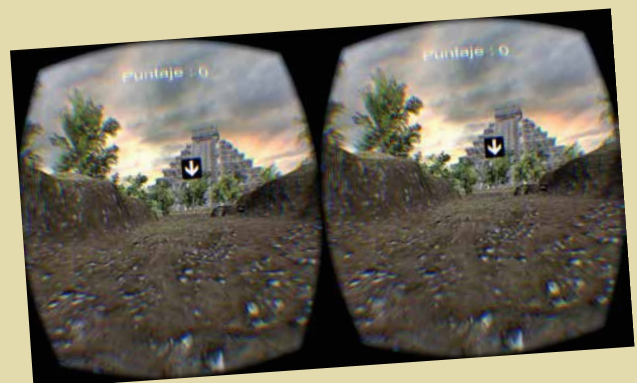
The different iterations of Reto Holtún had been demoed in diverse academic and industry events such as VirtualEduca (Peru), Guadalajara International Book Fair (Mexico), CES TransformingEDU (United States), and more recently SXSWedu (United States), obtaining favorable impressions and allowing the team to gather invaluable feedback from fellow experts from different countries.

Following this first VR game project, and starting right from the lessons learned and shared findings, LINNEA is now working on the early stages of two new VR projects: "Corredor" (Runner) and "El niño y la nube" (The boy and the cloud).

"Corredor" will take the user into a VR, fast-paced ultramarathon adventure across the majestic natural wonders of the world-renowned northern Mexico sierra and the cultural richness of its rarámuri ethnic group.

In a more recent application field, "El niño y la nube" will be an interactive VR, short animation movie, that will allow the user to learn about and develop empathy with the urgency of water scarcity issues.

With some of the top industry players pushing boundaries, mainly on the hardware side, consumer-level VR technology seems to be here to stay; the challenge for us educators and researchers will be to get over the soon-to-end hype with solid, scientifically-proven platforms, models and approaches that effectively align the potential of the technology with real-value learning experiences and improvements.



It is worth mentioning that the University of Chihuahua is the only Mexican, public university that works on Virtual Reality interactive learning experiences in the Latin American region, with projects founded mainly with the support of the Federal Ministry of Education.

An EdTech Innovation Center in Israel brings together teachers, students, developers and researchers, as a collaborative team, in order to explore VR learning potential. It is an exciting, unfamiliar, full-of-opportunities journey, but still in its beginnings.

DEVELOPING EDUCATIONAL VR EXPERIENCES

Graviton. MindCET VR learning experience



VR@MindCET

> Building a good experience is hard
Virtual Reality is a new medium. It is easy to "convince" educators about its WOW effects but in order to become a significant educational product, it has to offer a strong pedagogical value.

> The winner is not taking it all
Educators expect new products to provide a full solution. Educational VR experiences should be focused on a specific pedagogical learning objective in order to be effective.

> Testing, Testing, Testing
We are all still learning about this new environment (VR) and therefore it is essential to keep the user (student/teacher) as an intrinsic part of the development process.

> VR is a trigger for learning
MindCET R&D VR development experience shows that VR is ready to be a significant learning experience as long as it is contextualized within a pedagogical sound environment. VR learning objects need to be offered to the educators as part of a lesson plan.

A glimpse into our R&D Experience

When we first came into the VR world we tried to understand what value it could bring to education. We chose to focus on content related to human values and STEM, build different experiences and understand the added value that VR could bring to both fields. There were not enough VR educational experiences with students we could learn from. Our R&D team kept a close relationship with users, to learn from their feedback. We knew one thing: **If it could be simulated on the computer, and VR would not bring a significant added value to the user, it was not worth it!**



Ran Magen ///
Product Manager, MindCET
Expert in EdTech Innovative
Product Development

Using VR as an enabler of students' connection with their hometown

VR, as an immersive technology, can make the user believe he is another person or in another place. This place can be a fantastic world generated by computers, but VR can also capture the real world and give the user the feeling of being in another place. This can be a very powerful educational tool as we see in Google's Expeditions Pioneer program.

But, is it possible to use VR, not only to connect students to foreign places, but to help them feel more connected to their own hometown? To enable them to share their personal experience as residents with other people?

In an entrepreneurship project with students in Yerucham, a small town in the Southern District of Israel, a group of 9th grade students wanted to initiate an EdTech project to answer a specific need: to bridge the gap between their own experience of their hometown as a pleasant and friendly place, and the public image of this town as something boring, far away and neglected.

Using design thinking methods to plan their final EdTech product, they first conducted a survey among their social networks friends, and found that there was a difference between people who had visited Yerucham and people who had only heard about it in the news. They therefore concluded that the solution had to be: using technology to create a real-life experience of visiting Yerucham; and what can be a more real-life experience than VR?

With only their smartphones (using Google Street View app) they roamed across Yerucham and shot 360° photos of the most cool and beautiful places in the town. They added some atmospheric music and uploaded the photos to a website we created together with the students.

> **The experience of VR is powerful enough** even in its more accessible versions by using Google Cardboard – the low-tech VR gadget is immersive enough to produce an impression and experience which is nearly like visiting another place.

> **Anyone can create a VR experience.** Although the more interactive VR games and movies are still limited to experts, any teacher can create 360° images using only the students' smartphones in order to capture real-life places and events and transmit them to others. For now this applies only to still images but as the market of 360° cameras is developing quickly, capturing 360° videos will become more accessible.

> **Sharing with your community is more fun with VR and a smartphone.** You can ask your students to capture a snapshot of their homes, on their way to school or a moment on their vacation, and share it with others in an easy and engaging way.

Empathy Skills & VR

The hallway

The user is immersed in a first-person experience by walking through a school hallway. As the user approaches other avatars involved in social activities, doors are closed in his/her face. The user is led to feel the insult of being rejected, yet he/she doesn't understand why. This lack of knowledge increases the helplessness of the user in the situation. Only at the end of the experience the user learn that his/her color is different than the other avatars.

Added pedagogical value: The sense of presence in a VR experience makes the user realistically feel strong emotions and therefore enables him/her to better empathize with others in similar situations. The experience serves as a trigger for discussion in educational settings.

I am the other

The user is immersed in a familiar environment, but sees everything from a different point of view; this awkward experience makes the user try to find an explanation. During the experience there are several occurrences that lead the user to understand that he/she is a dog. This first-person experience forces the user to perceive the environment from the perspective of the other.

Added pedagogical value: This experience offers a unique opportunity for the user to understand a familiar environment from the perspective of another being. This facilitates a conversation led by educators on empathy and understanding others. From our testing we learnt that it helps students understand that different beings perceive the environment from different points of view.

Physics & VR

Playground on different planets

Teaching the concept of gravity is not an easy task for teachers. The students are bound by their life experiences and find it difficult to understand the behavior of objects in different physical environments. In order to facilitate learning we've developed a playground taking place on Earth, Jupiter and the Moon. Students can swing, jump, and play, experiencing how these activities feel under different physical environmental conditions. By using a VR headset the user can control different aspects of the scenarios like the mass, height and velocity.

Added pedagogical value: By experiencing the behavior of different environments, the student goes through a vivid, and not merely conceptual, explanation of physics theories. This understanding helps students improve their intuition regarding physics concepts and thus their ability to solve problems. From our testing, it helped students explain physics laws intuitively before conceptually learning them.



Ilan Ben Yaakov ///
PhD in Jewish Thought,
MindCET Pedagogic Director



Google Expedition Pioneer Program

Enabling teachers to bring students to places a school bus cannot go

We live on a different era, access to information has changed the way students learn and teachers teach. It's important to prepare students for the challenges and jobs that doesn't exist today and embrace a culture beyond classrooms, one that promotes curiosity, research and teamwork. Technology is one of the reasons for changing education, but it is also the tool to make this change happen. Technology is changing many industries and it has the potential to transform education.

Experiences are critical to learning and we're not far off a future where experiences can be enjoyed by the same children, regardless of where they were born or their families' socioeconomic background.

We've seen the democratization of knowledge through the internet and Google Search and we've seen how access to information can transform individuals and communities. We believe fundamentally that it's now time for the democratization of experience and our team feels like it has a moral obligation to make this happen.

Teachers are always looking for new ways to engage with students and make knowledge more interesting. We think technology can play a key role in these tasks. We believe in the power of virtual reality as a powerful learning tool for teachers to engage their students with a new dimension of discovery. That's why we built Google Expeditions and launched the Expeditions Pioneer Program.

We want to enable teachers to bring students on virtual trips to places – museums, underwater, outer space – that a school bus can't go.

We worked with teachers and content partners from around the world to create more than 150 engaging journeys - making it easy to immerse students in entirely new experiences and adapt the Expeditions to existing lessons and curriculum. While nothing replaces getting on a bus and going on a field trip, virtual reality enables experiences to happen when they would otherwise not.



Jennifer Holland ///

Over her 9 years at Google, she has worked in Finance, Sales, and now Product. Jennifer is the Google Classroom and Expeditions Program Manager, and her team built both the Classroom and Expeditions products from the ground up by prototyping and testing extensively with teachers and students in schools around the world



Miriam Reiner ///

Prof. Miriam Reiner, head of the Virtual Reality and Neurocognition lab, Faculty of Education in Science and Technology, Technion; Currently Visiting Prof. at Stanford.

when SOCIAL NETWORKS meet VIRTUAL / AUGMENTED REALITY

We are social animals, with a profound need to connect and belong. This need to connect is as vital as our need for food and water. We have an irresistible need to understand the thoughts and emotions of people around us, respond and seek for meaning, then look for our own acceptance, in a never-ending cycle of human-human interaction. Indeed social network technologies are soaring, responding to our fundamental, innate, blueprinted need to interact with others. So is Virtual/Augmented Reality.



Although Virtual and Augmented Reality have been on the center stage for a while now, it was in April 2016 that Google Trends showed a sharp peak following an exponential increase in the consumers' interest in Virtual Reality since May 2015. Simultaneously the use of avatars for social interaction in Virtual Reality was similarly soaring in a variety of social applications and games, providing exciting tools for a new level of immersiveness in social meeting rooms. It seems inevitable that Virtual/Augmented Reality will meet social networks, so the two trends of virtual-realistic avatars and social media intersect. Indeed the Facebook announcement of purchasing Oculus in 2014 suggested exactly that: "Imagine enjoying a court side seat at a game, studying in a classroom of students and teachers all over the world or consulting with a doctor face-to-face – just by putting on goggles in your home. This is really a new communication platform. By feeling truly present, you can share unbounded spaces and experiences with the people in your life..." ►



Current technologies enable constructing avatars that are physically similar to the user but limited in their non-human dynamics, with impoverished expressions and body language. Will the use of such avatars alter our social life and behaviors in a new type of social network? What else would be needed to enhance our social-avatar experience to resemble the shared emotional thrill, excitement, trust and togetherness, delight or empathy of true social human experience?

Responding to this question requires a deeper look at the core mental functions that constitute human-human communication, and that turn us into such expert social creatures.



It is widely agreed that the brain has developed to cope with life in complexly bonded interactive social groups, that act together to achieve shared goals, and thereby increase survival probabilities. Fast and clear factual and emotional communication is crucial for coordinated action – be it hunting, taking care of the weak, or leading a new entrepreneurial startup.

Social cognition is embedded in our behavioral machinery, sculpts the 'self' and shapes our action, providing the tools for a supreme ability to interact, cooperate and collaborate with others.

In social interaction states, most of the information is not conveyed verbally, nor through signs and symbols. Evidence shows that in a group discussion, less than 10% of the information is conveyed through words. Some is conveyed through body language, some cues are perceived without our awareness. Even slight changes in skin color, in the shape of the eye, in the size of the pupil, in the gaze direction, in saccades all convey information to the interacting human. Widening pupils carry an emotional message that humans pick up unwaveringly. The phenomenon of mirroring and "rapport," a state of synchronization between behavioral, emotional and physiological features of the cooperating humans, shapes our decision making and course of action.



Human-human interaction is embedded, in teaching and team work, in social meetings and games, and even for understanding the emotional state of a refugee viewed through the oculus in virtual journalism. Thus expressing, and involving, our 'social self' is crucial in any social application. Are the current V/AR technologies equipped with the tools to allow using our social cognition qualities? Are the newly emerging technologies of Virtual/Augmented Reality adapted to our brain and bodily machinery, to allow our social selves to be expressed? Do the current V/AR technologies carry the ability for such efficient social applications? The answer is obviously, not yet.

The current social Virtual Reality technologies turn us into limited, partial, imperfect, restricted and meager social animals. The avatar needs much more than just to look like 'me.' It needs to have the ability to convey, e.g. excitement – through changes in facial skin color, in eyes dynamics, posture and motor patterns of the bodily gestures – in a natural way, that fits the human perceptual system, and which is still far away from the current features of available avatars.



Professor Reiner
AVATAR



Another central human social ability is 'Theory of Mind' (ToM). For instance, in describing your most exciting work to a colleague, if you are like most humans, you will automatically be able

to notice how excited (or not) that person is. You activated your ability to create a theory of the mind of the other. It refers to the human mental capacity to mentalize the other, i.e. attribute beliefs, intents, emotions, cheating, pretending, to others, and then respond accordingly (some mental pathologies, e.g. autism, are hypothesized to lack the ability to 'read' the other). This is crucial for identifying cheaters, for constructing relevant responses. Empirical support for these ideas came from neuroscience, with Gallese and Arbib's finding of the human 'mirror neuron system.' These are brain areas and processes that respond to both self-actions and when watching actions of others. For instance, when watching a music teacher demonstrating a piano sequence, the observer's brain networks are activated similarly as if s/he is playing a piano.

Human neuroimaging studies have also shown that the areas associated with self-action are also active during imitation and during observation of another person performing the same act. It is the activation of the mirror neuron system that is considered to be involved in building a theory of mind – i.e. how we read emotions of the other, feel empathy, and develop trust. Nalini Ambady from Stanford showed that it takes no more than 30 seconds to develop trust. In brain imaging studies, Todorov, a neuroscientist from Princeton, showed that it takes as little as 100 milliseconds to judge valence of a new face. It is a social-cognitive function that we recruit automatically, without being aware, without thinking, in order to decide whom to bond with, whom to trust. And it is not performed through rational logical inferences. It is fast, frugal and automated, and is probably so because of its high value for survival.

Developing human empathy is processed fast by the brain – within the range of hundreds of milliseconds the areas correlated with trust are already activated. Developing empathy and in general perceiving emotions is based on activation of areas that are part of the mirror neuron system, which is also activated when building a theory of the mind of the other, including mimicking and social learning.

Reading the face of the other requires specific conditions. For the brain to efficiently read the emotions of the other, it has been shown by Dahan and Reiner in a 2016 study that the motion must be 'biological,' a motion typical of humans. Is the dynamics of the facial expression of avatars biological? All applications in which we interact with an avatar that represents a human are far from conveying human/biological dynamics.

For instance the VR meeting applications, the Facebook-Oculus application, vTime, provide users with the technology to meet up with friends in virtual reality, in real time. The users log in and then build an avatar. The avatar might – or might not, depending on the user – look physically like the user. While much better than anything else that exists, motion in real time is not biological, hence not automatically recognizable by the brain.

Do we feel deep empathy, as we feel with real humans, in interacting with such avatars? Do we develop trust in the 'other-avatar,' as we would with humans? Can we develop a theory of mind and efficiently recruit our natural social faculties to interact as we are equipped to? Probably not. There is still a long way to go, a large technological and theoretical framework to develop.



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