VR/AR Association White Paper

Virtual and Augmented Reality Best Practices for Education

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Preface

“The true sign of intelligence is not knowledge but imagination.”
Quoted by Albert Einstein

Education is the driver to sustainability of our economy and functionality of humanity. Every day we seek to learn new information and and the way we take the lessons and apply to our every day lives, is the core of how we explore we grow and we build futures for ourselves.

Through virtual and augmented realities, the technology allows the user to immerse themselves into a virtual experience or location and the immersive lesson is retained at a much quicker time frame with a more impactful lasting memory. VR & Learning, by the National Training Laboratory, advised retention rates for lecture style learning were at 5%, with reading rates at 10%. Meanwhile, the teaching method of VR scored a retention rate of 75%.

Understanding we are moving into a world with exponential growth, there is a necessary requirement to update our education system to support innovative technologies to understand how it will be applied to job creation and support digital support systems and processes.

Opportunity

Humanity is at the beginning of a Fourth Industrial Revolution which is building on both VR & AR applications and solutions. The changes to the way we teach and the curriculum needed to support innovative time is required to support the graduating generations into a workforce rapidly changing and evolving using digital applications not yet taught in our schools systems. Day to day operations and day to day systems will be using VR and AR systems to engage in the operations such as.

VR & AR for Education is mandated for the following reasons:

- To engage our current students and future generations in this Digital Age
- To provide education of the tools, the technology, the applications of VR & AR to be used in future jobs
- To provide best practices for the classrooms
- To provide engagement tools for Students, Parents & resources for Teachers & Mentors
- To be the leader and resource of VR & AR applications that relate to extending knowledge to support the application, build or creation of the technology to use in our every day lives

The potential benefits of using VR and AR in educational activities has been investigated for many years by researchers. The investment to facilitate access to massive scale virtual content in Q1 2016 was around $1.2 billion, and it is expected to obtain $120 billion in profits by 2020. The investment is mainly focused to create virtual content and to manufacture VR devices that will interact with this content.

Creating jobs and increasing productivity are at the top of the agenda for policymakers across the world. Skillset development will be an essential component of all efforts globally.

The current workforce in most countries are not ready to meet the needs particularly in more competitive economic environments. In many countries, education systems are not providing young people with the basic skill sets both cognitive and behavioural, or have coping mechanisms in place to support the changes to come to make them “trainable.”(World Bank. Education Overview March 2017).

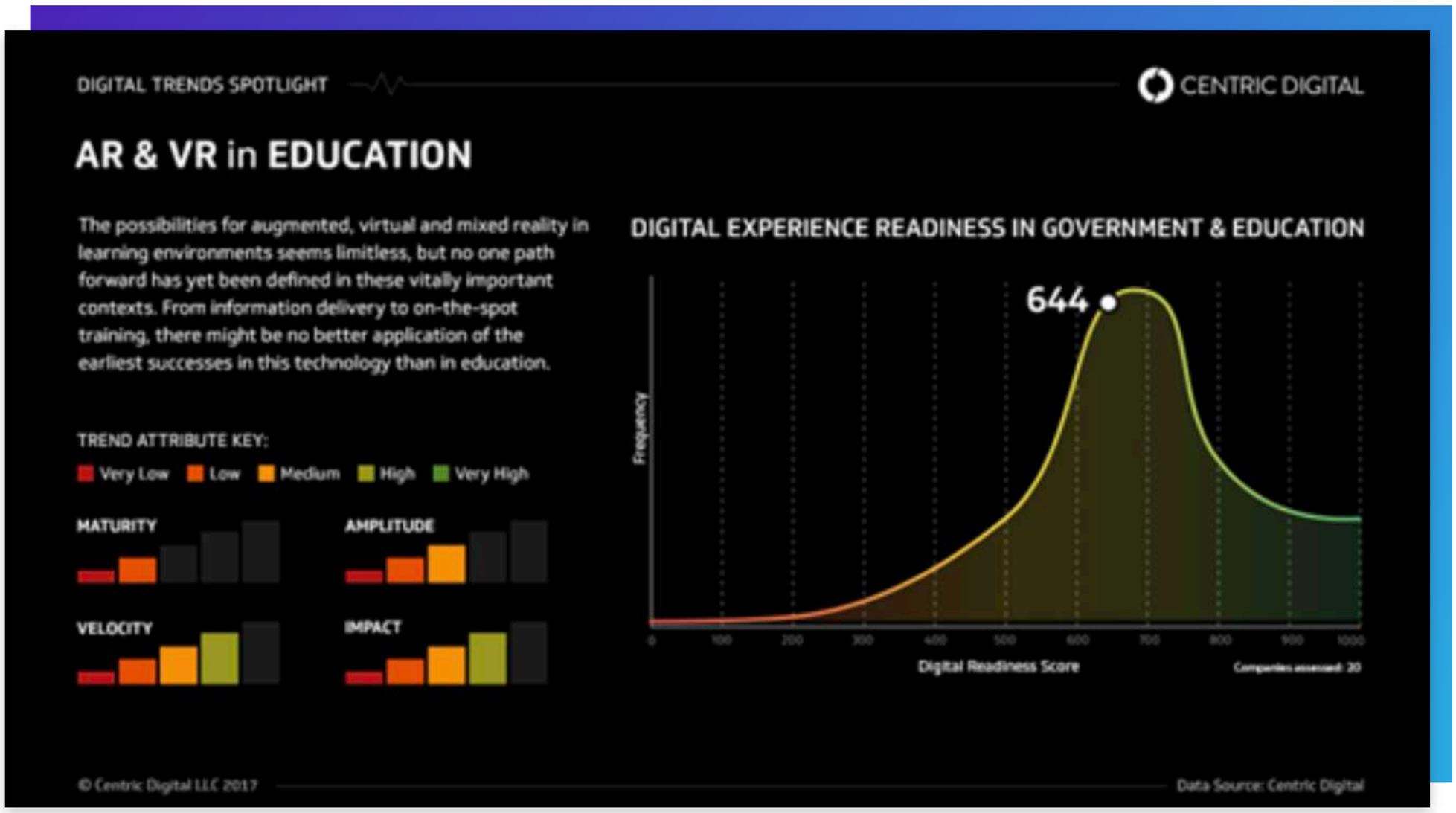
VR/AR technology is set to disrupt both the higher education and vocational training markets with a growing interest of the adoption of virtual and AR applications in education; particularly in simulations and virtual exploration. (Goldman Sachs VR/AR 2016).

VR/AR technology can enable students and engineers to understand complex concepts, test risk scenarios and make better decisions. Cutting down learning time, cost in training, improving quality, reducing failure and drop out rates. The engagement is higher and applicable.

The potential user base is growing every year and the number of higher education students worldwide is reaching 200+ million.

The challenge and this renewed interest are driven in part by lowered costs, increased content availability, and the explosive popularity of VR and AR games such as Pokémon GO. However, there is still a significant trade-off between price and quality in many of the VR/AR tools available. Education Centers, teachers, students, and engineers need access to High-Value VR content and methodologies that must be developed by the specific industries at large.

The global education market disrupted is about +20bn € according to research and market analyst (2017), and the business opportunity estimated is around +5bn € by 2025.



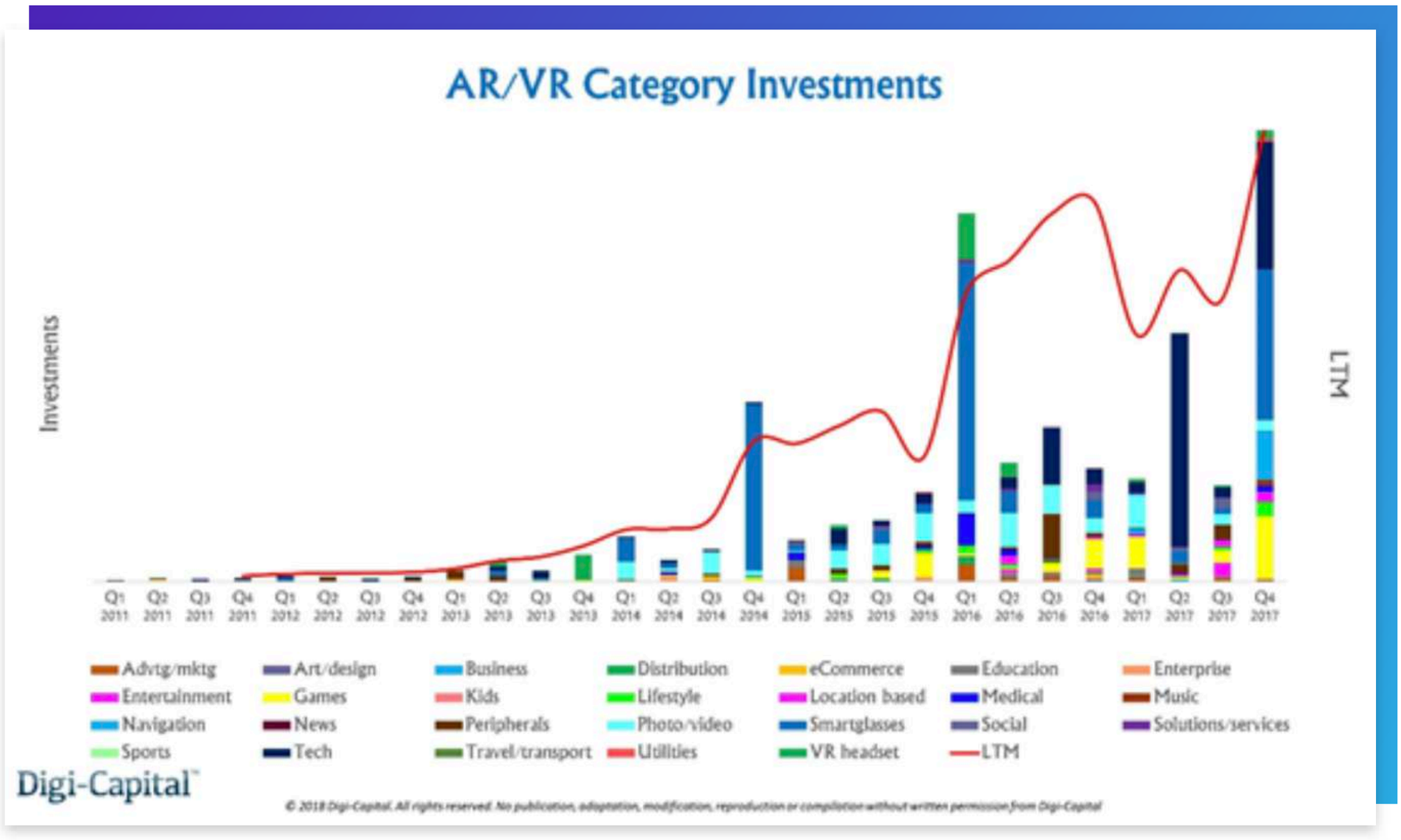
Previously encumbered by a combination of technology gaps and consumer readiness issues, VR is poised for considerable global growth, providing abundant opportunities for service providers, content developers, and ecosystem component providers.

Anticipated VR growth is driven by critical factors including an anticipated precipitative price decline for consumer headsets, which will spur VR device adoption and facilitate VR application and content development. It is important to note that VR & AR Education and other immersive technologies will be important to many vertical industries' that leverage the technology to educate through training, sales processes and use Mixed Reality for a variety of enterprise purposes including internal operations, managing supply chain and systems processes.

More low-cost VR device options and mobile VR, such as Google Cardboard, and consumers are becoming increasingly aware of VR and immersive technologies in general. Preferences to be untethered, and have high bandwidths in VR is important for adoption and usability.

With the implementation of 5G throughout some countries, we can expect to see mass adoption of full-featured, mobile supported and fully immersive VR technologies with the speed of data transfer the applications will become synchronized at faster speeds interchanging information at a faster speed rate,

With Mobile Edge Computing (MEC), VR will also have a substantial impact on VR as MEC will provide much-needed computational optimization, especially for LTE only coverage areas and while roaming.



Introduction

This document outlines and details a set of recommendations, best practices, reference guides and case studies aiming to capture the rapidly evolving field of VR/AR/MR and its use in education and skills development. It is intended for novices, experts, managers and decision-makers who are knowledgeable in current education methodologies and interested in digital education transformation.

The document is structured into chapters, explaining all basic concepts, requirements, and experiences; the Educational Community should know about Immersive Technologies for best practices for Educational Centers, Institutions, Vocational Training Centers, and Universities.

While this document provides an extensive discussion of current best practices and usages, VR and AR continue to grow organically and rapidly. We encourage experimentation to push the boundaries of what is currently possible with this technology.

The VRARA Education Committee will ensure this document is current through regular updates, and will integrate case studies, norms, standards, and ethics recommendations.

Introduction to the VR/AR Association (VRARA)

The VR/AR Association is an international organization with thousands of registered companies and schools and over 50 global chapters. Its mission is to accelerate collaboration in the rapidly developing VR and AR ecosystem to promote research, education, and the development of industry standards.

The VRARA Education Committee

The VR/AR Association (VRARA) Education Committee is represented globally and through our initiatives, we bring together the best use cases to see first-hand how immersive experiences are changing the way people connect with information, experiences, and each other.

The Education Committee is comprised of education professionals, technologists, digital media creators, business leaders, and entrepreneurs that bring tangible experience from their domain and real-world application of VR/AR technology.

The mission of the committee is to create best practices, guidelines, and call to actions (e.g., recommendations for standards) for Education.

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1 Future Work Skills, Reimagining Digital Education

Education is a System; Teaching is an Action; Learning is a Process.

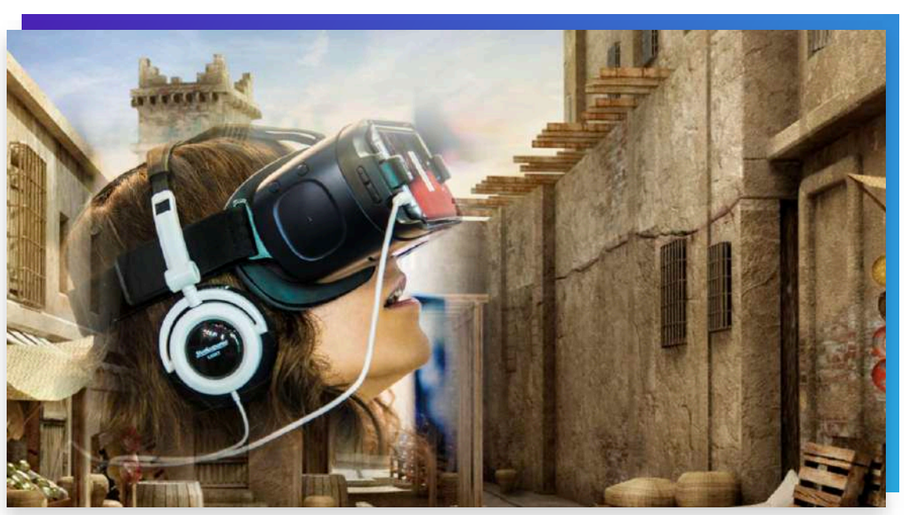
The Institute for the Future, teamed up with the University of Phoenix Research Institute to identify skills that will be needed in the workplace by the year 2020, which include:

- **Sense-Making:** Determining the deeper meaning or significance of what is being expressed
- **Social Intelligence:** Connecting to others and sensing and stimulating reactions in people
- **Novel and Adaptive Thinking:** Thinking with creative solutions to address problems
- **Cross-Cultural Competency:** Operating in different cultural settings
- **Computational Thinking:** Translating vast amounts of data into abstract concepts and understanding data-based reasoning
- **New Media Literacy:** Leveraging, critically assessing, and developing content, using new media forms
- **Transdisciplinarity:** Understanding concepts across multiple disciplines
- **Design Mindset:** Representing and developing tasks and work processes for desired outcomes
- **Cognitive Load Management:** Discriminating and filtering for important information and mastering new tools to manage it
- **Virtual Collaboration:** Working productively, driving engagement, and being present as a member of a virtual team

Schooling is not the same as learning. When improving learning becomes a priority, great progress is possible. That means that Educational Systems must focus on three key aspects:

1. Assessment
2. Alignment
3. Action

Both assessment and alignment of learning outcomes most educators are familiar with. It is the action to take based upon the results of the the learning outcomes is required to change. To simplify the next step, educators should move from a Teacher based education model to a Student-centered model, as the first action required. Teachers need to be engaged as mentors, entrepreneurs, and change leaders; adapting their subject knowledge to the new platform and tools available in VR/AR for the students. By doing this first action, the students now are at the center of all of the opportunities, paths and learner-centered engagement.



Reimagining Education in a "Smart Environment"

2 VR/AR Educational Ecosystem

In times of change, we need to apply a disruptive innovative model in education.

2.1 Disruptive Innovation in Education

The incredible rise of smartphone adoption has fueled the VR revolution; giving it the push required to influence a pedagogical shift in the field of education and learning.

VR is becoming more of a possibility in the classroom as some mobile handset makers are now integrating this technology in the handset itself. Needless to say, the use of VR/AR in the classroom is in its infancy. However, with innovations coming from companies creating virtual environments, immersive simulations, digital value content for the classroom is being built.

According to the NMC/CoSN Horizon Report 2017 K–12 Edition highlighted in this document, you will find a profound analysis of Key Trends Accelerating Technology Adoption in K–12 Education. Moreover, we will go into some specific details regarding VR/AR technology and other related issues like Redesigning Learning Spaces.

2.2 VR & AR Definitions

VR refers to a completely simulated reality, which is built with computer systems by using digital formats in immersive environments. Building and visualizing this alternative reality requires a specific hardware and software. Name the hardware and software.

AR superimposes synthetic digital elements like 3D objects, multimedia contents or text information onto real-world images; increasing its possibilities of interaction with the user. (ie. Pokemon Go)

Universities and Schools around the world have opened a first-of-its-kind VR learning centres that have been designed to allow students from various disciplines to learn through “New Technologies VR/AR”. All of these activities are engaging the students within the correct context, allowing them to interact and take ownership of their own education.

2

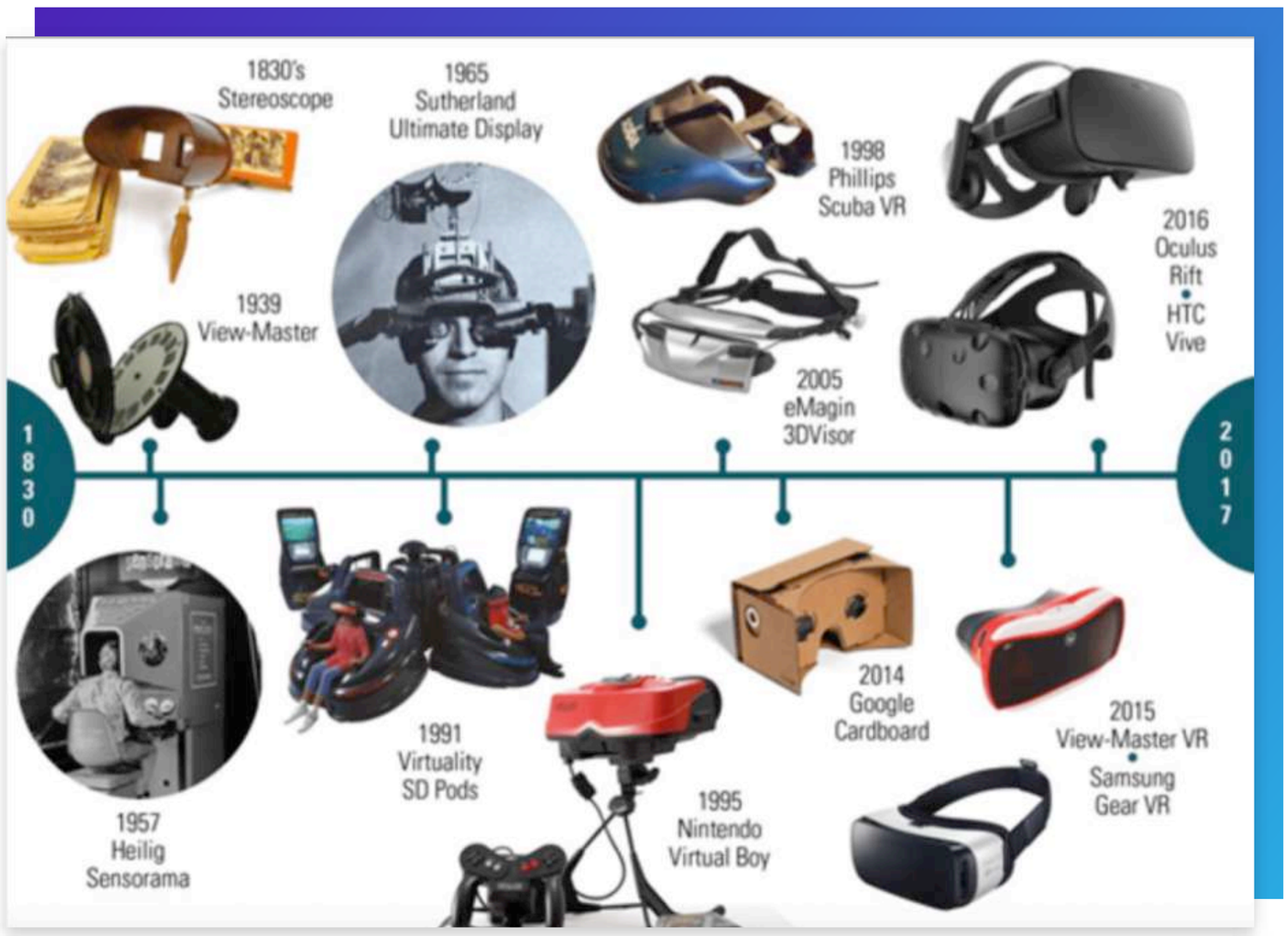
Mixed Reality are both virtual spaces and physical spaces where real-world objects or people are dynamically integrated into virtual worlds or where synthetic digital interfaces/objects can be over-layed and integrated into real environments to produce new mixed reality experiences.(provide a magic leap example)

Key aspects linked to VR/AR system are: Immersion, Interaction, and Visual Realism. Immersion is created by surrounding the user with virtual technologies and devices, e.g. virtual glasses, gloves, haptics (movement feedback sensors), HMDs(head mounted displays), surround/ambisonics sound, and any other elements creating sensorial stimuli that enables the user to interact with a virtual environment.

Immersion is a vital consideration in all VR endeavours, for example “How immersive does this experience feel? How easily can people suspend their doubts and really feel like they are in this reality? In fact, VR can be divided into categories based on the level of immersion.

Non-immersive VR, using 3 degrees of freedom, and usually experienced with a google cardboard headset, allows elements of the real world to creep in through the corners.

Semi-immersive VR simulations use a combination of real-world objects and virtual objects to replicate an experience. The easiest and most common example of this is the cockpit simulation used for both games and flight training. It looks real, and the visuals are digital while the controls are physical but you still have the sense of being in the real world.(name the experience)



2 **Fully immersive VR** creates an entirely digital environment to explore (with the exception controlling a physical accessory/haptic gun or sword-like object in your hands). These environments may be limited by space, as with today's gaming console VR headsets, or they can include full 3D environments in the real world that you can explore, which are tracked, copied, and filled out inside the simulation.

Mobile VR: Using three degrees of freedom, consists of headsets such as Google Daydream, Samsung Gear VR, and a wide variety of Cardboard type viewers with a smartphone device attached to the headset. The cardboard experiences tend to limit motion and head tracking, the field of view and lack the ability to use hands and feet in the experience. Mobile VR is ideal for different application fields and scenarios where you must consider internet connectivity.

Casual VR is good for gaming, virtual tours, experiencing 360-degree video, 360-degree photography, vocational training, education and standalone activities. It is important to note here that content development costs will vary depending on the type of hardware the user employs, but it can be fully compatible with PC based applications, using same hand controller's functionality.

PC or console based VR: Using six degrees of freedom is designed for a richer and professional immersive experience. Due to the processing power of PCs, as well as, controllers and peripherals (e.g. hand controllers), the experiences create a far greater feeling of "being there" for the user; a powerful feeling of presence. The head and motion tracking are more accurate and flexible for the users thereby allowing them to feel truly immersed. Systems used for this application required a High-end laptop and advanced headset devices such as Oculus Rift or HTC VIVE which both have hand controllers to engage in the experience.

Haptic feedback: Haptic means the ability to touch and manipulate objects using a part of your body, like your hand or back with vibrational sensors that match the visual impact of the experience. Gloves are an example of haptics that provide feedback through timed vibration in a VR experience.

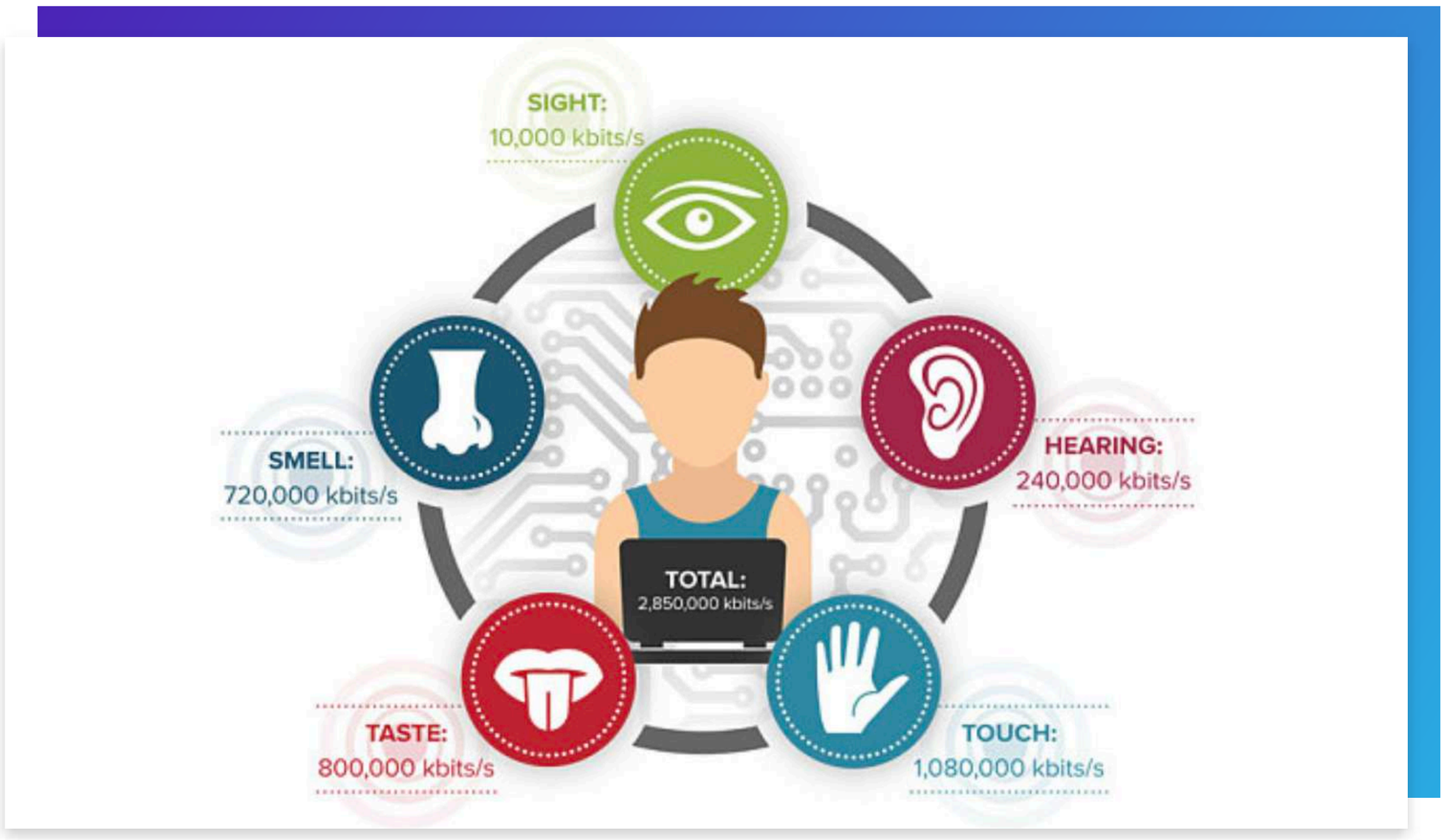
2

PC VR is ideal for simulations, enterprise training, higher education, high-end AAA VR gaming, exceptional media experiences, visualization for design, complex industry simulations, and high-risk emergency simulation scenarios.

Standalone VR: is a next-generation type VR experience that will be brought to market by different Industry manufactures initiatives. The very first headsets were developed in China based on All-In-One VR Android devices in 2015. Nevertheless, the main barrier to entry was the lack of content ready for those devices. Standalones are wireless. It is helpful to understand, however not all wireless VR headsets are standalone. Some systems beam information wirelessly from nearby PCs or consoles and others use wired packs that clip to clothing or slip in a pocket. Some dreamers hope for a true standalone with the processor, graphics, display, storage and tracking all integrated into the headband.

From Reality to VR

VR simulates the physical presence of the user in a virtual environment, which is categorized as sensory-motoric, cognitive, and emotional. However, VR also creates an immersive 3D spatial experience when the user perceives that he or she belongs in the virtual world. To be credible, this perception requires real-time interaction, so that the user gets instant feedback from his or her movements, position, and sensations. This feedback permits the user reacting and sending commands to a computer by using trackers, gloves, keyboards, or any other input device simulating realworld user's reactions. Output devices (visual, aural, or haptic) should create a realistic illusion, so that hardware and software should be able to render detailed and realistic virtual scenarios, and have to handle geometry, texture, and physical models to be credible and accepted.



2 2.4 VR/AR Educational Platforms for Beginners

Focusing initially on the most critical components: Devices, Contents, Activities, and Connection.

VR/AR Devices: In a beginner's context, we will focus on mobile devices. Since these allow us to have capabilities that are far superior to any other device at present, at a very affordable cost because of the value it provides. Smartphones will allow us to download VR applications, as well as AR apps, take pictures and videos, panoramic 360º, and interact with other classroom content or external resources. If it has a gyroscope and accelerometer, you are able to incorporate them into a VR headset to enjoy an immersive VR experience. Regarding the headsets, we have made a comparative study that can be consulted in the white paper graphics.

VR/AR Content: In this case, we have incorporated a summary of the best existing VR / AR Resource platforms in the network in Chapter 4 and 5. VR/AR Activities: This is the key point for the success of the correct and efficient implementation of VR / AR technology. It is here, where teachers and students establish the rules of work and actions. An appropriate methodology will allow the development of creative and high-value activities for students, allowing the reuse of creative, and innovative content. Methodologies based on actions or projects, which are grounded in real cases, are the key to success.

Internet connection. This is a critical dependency in many VR/AR use cases and must be anticipated in an imaginative and creative way. Be cognizant of off-line interoperability and plan accordingly. As we integrate 5G Network Communications, the data exchange will be completely dependant on the functionality of the program and immersion.

3 VR/AR in Education

"If we wish to prepare a generation of citizens, entrepreneurs, and leaders for the 21st. Century who can face real-world problems, we must give them real-world problems to solve." Quoted by Teach Thought, the Future of Learning.

3.1 Innovation in Education

The most effective methods, involves direct, purposeful learning experiences, such as hands-on or field experience. Direct purposeful experiences represent reality or the closest things to real, everyday life. "Action-learning" techniques result in up to 90% retention. People learn best when they use perceptual learning styles. Perceptual learning styles are sensory based. The more sensory channels possible in interacting with a resource, the better chance that many students can learn from it.

Imagine a Virtual Laboratory, with different instruments, devices, components, and substances. Now picture, creating the content for the lab and defining all the lab processes focusing on the user experience. In the beginning, it will be a significant amount of work; however, after lab set-up a multitude of students can interact in this Virtual Lab and share their knowledge and experience at the same time. In these new Education systems, students can learn by doing, practicing, experimenting and training until they reach the objective.

In addition, teachers are starting to use AR in classroom lessons, to support their class material with AR features. It engages students as well as motivates them to study. Adding extra information like a short biography of a person, some fun facts, geolocation, visual models of math concepts and more. By including AR into lessons educators directly involve students in the studying process by interacting with a 3D model of the subject matter; a contextualized version of the learning material.

AR tutorial animations and graphics content also give extra educational opportunities to students of all ages. There are many AR SDKS for AR development for both iOS and Android. To mention some: Vuforia, EasyAR, Wikitude, AR toolkit, Kudan, Maxst, Xzimg, and NyARToolkit.

VR & AR not only facilitates learning but changes the environment around students. It allows students to have agency in their educational journey and can render exciting learning worlds as small as the atom or as big as the cosmos.

A nationwide survey of 1,000 K-12 teachers said 60% of educators were keen to make VR part of the overall educational experience; even though only 2% of teachers had already used VR as a teaching aid.

Although VR was seen as a boom to education sector as a whole, the next challenge is to implement VR/AR/MR into mainstream usage in schools and education systems across the board.

3

3.2 Barriers to entry

To get this immersive experience delivered to the students, educational institutions need moderately-expensive smartphones, a tablet for the teacher and VR glasses. Below are the components required.

1. The Cost: Oculus Rift or HTC VIVE headsets are $300-$600 plus supporting computer to manage the graphics card and operating system, which suggests its use in classrooms might be limited to a few centers and private schools. Also there is still the issue of content; or a lack of thereof that justifies the investment. The VR Cardboard itself is inexpensive, but you need to add the smartphone with VR requirements and content. It is a good option because you can run VR/AR apps on your device, but it must be a high-end mobile. You could find different solutions from high-end Samsung Gear to Google Cardboard from +$ 500 to +$ 200 per unit. In the case of AR technology, the price is not a barrier to entry because there are many single and complex educational apps for any existing devices.

Technological literacy: The 2014 RAND report defines technological literacy as “the ability to use computer-based devices, software, and networks,” where “use” refers not only to operating the relevant devices but also to “advanced abilities to learn, analyze, and explore.” Similar to gaps that open up early on in a child’s life regarding word acquisition, on average, students from low-income households are at a disadvantage concerning technological literacy. Low-income families on average have fewer, older, and less portable devices, and students from low-income backgrounds are more likely to use the internet for entertainment and social purposes rather than education. Teachers and administrators, particularly those serving students whose technological literacy lags behind those of their wealthier peers, may be hesitant to invest in VR if it seems unlikely that this technology will enhance their students’ learning.

Likewise, without accompanying professional development or alignment to determine content standards, teachers lack the tools to integrate VR into their daily classroom routines. Therefore, a Teacher’s gap analysis must be done prior to formal training programs for VR/AR/MR tech are developed; so that the right fit of training is created to meet the needs of the educators. Then, the additional step of integrating the tech into the core curriculum as a specific learning tool for improved learning outcomes.

Finally, the demand from the Student’s; In general terms, all the students consider didactic VR resources easy to use (as it would be expected, considering the students’ familiarity with the latest generation of video games, which are designed with the same type of VR software). According to students’ opinion, the most important aspects in a didactic VR tool would be to bring to life learning and provide hands-on educational lessons in a VR environment.

3

3.3 Benefits and Values of VR/AR in Education

As it is more actively adopted, VR will be increasingly found in educational spaces. According to the most relevant industry and research studies, VR will play a differential factor in the new educational scenario. About one-third of the tech-orientated attendees surveyed at CES 2016 think that education is the area that is most likely to benefit from VR with virtual classrooms and VR-enabled textbooks. As VR expands its reach into the educational sector, we must explore the tangible impacts that this technology will have on both students and educators in our classrooms. Here we demonstrate some of the definitive benefits of using VR in the classroom backed by research.

Adding value to the Classroom: A recent study published in the Journal of Media Education reported that students spent a fifth of their time in class performing activities on their devices that have nothing to do with their schoolwork. In fact, the study found that students check their digital devices an average of 12 times during class. Leveraging those smartphones for VR/AR applications could potentially eliminate this problem. Instead of spending idle time on their phones, students would instead be required to use them to engage with VR software for the lesson of the day. BYOD can bridge the Attention Gap: Edger Dale's Cone of Experience has shown that the average person only remembers 20% of what they hear and 30% of what they see, but up to 90% of what they personally experience. As a result, VR/AR educational materials can provide the scenario needed to close the attention gap. For example, in a meta-analysis done in 2014, researchers found that students actually do learn better when immersed in virtual worlds.

Eliminating Language Barriers: In today's multicultural societies, bringing students together from different backgrounds is still a challenge due to language differences. For students that wish to study in another country, traditional methods of teaching have always required that they achieve sufficient fluency in order to effectively learn in a classroom where lessons are taught in another language. With VR/AR, language translation can be implemented within the software, eliminating language as a significant barrier to a student's educational goals.

Social Integration of Students: Helping students to connect with their peers is essential for creating a positive learning environment for students. VR/AR technology can foster social integration of learners within a classroom environment by bringing together students who have different learning styles and needs.

Rewarding Students for their achievements: Much of the traditional approach to education has made success neutral while punishing students for failures. With VR/AR apps, content producers can bring the gamification aspects of technology that have enhanced other consumer products to educational materials.

Delaying rewards actually eliminates all motivating power of the incentive. Implementing rewards systems into VR/AR educational software could potentially deliver significant results with regard to student achievements in previously low- performing academic environments.

Learning from my experience in the IT Edu sector, I really think the great equalizer for equity with students is experiences. Experiences bridge that gap to give them opportunities to know what is out there. Imagine the opportunity to interconnect students in virtual communities from different regions, and countries to share their knowledge or connect with professional experts about real life experiences.

4 VR/AR Educational Content

Content is the key for VR/AR technology and in a very special way in Education. You can find 360º and immersive videos, games, experiences in multiple formats and configurations and educational applications. Most VR headset manufacturers made a big effort to provide content platforms and developer environments to help creatives to develop high quality and immersive content.

In this chapter, we will emphasize content, platforms, monitoring, evaluation, instructional design, and technology integration. Digitizing educational content, bringing devices to school, and one-off stand-alone learning apps are basic steps in the drive toward bringing technology into classrooms. However, we must consider some important and relevant issues before any further consideration of content is explored:

- What kind of content do we need for VR/AR, Curricular or Extracurricular or both?
- Will it be integrated into an LMS, a free CMS, or proprietary platform?
- What about Steam Education needs ?
- Do we need to consider some standards like Scorm or Tin Can?
- What kind of instructional design do we need?
- Will we use ad-hoc content, simulators, videos, and virtual labs?
- What are the advantages of five senses interactive content?
- How will be the students be evaluated?
- How do we measure and track the impact of technology in the classroom?
- What is the role of teachers and students in content creation?

New technologies, like VR/AR, will likely make it easier for students of all ages and backgrounds to continue their education their entire lives, both inside and outside the classroom. These technologies can address the three drivers of change: fortifying student skills, increasing education's ROI, and enabling students to be more innovative and entrepreneurial. To address these challenges, ed-tech solution providers will likely need to shift focus from content to connections.

4

4.1 Types of VR Content

Games: Gamification is required in this new educational environment. Playing games in VR to measure knowledge adds a new dimension to the educational experience. Analysis of eye tracking, cognitive and sensory engagement will play a huge part to measure the user retainer of information and also provides analysis in the immersion process.

360º Immersive Video: 360° Video content is useful in the training and learning sector. VR can also be used to deliver other educational experiences through what's generally becoming 360º video. New storytelling and immersive narratives in VR provide multiple opportunities in education at relatively low cost for the immersion experience.

Experiences: One of the main differentiation factors of VR is the opportunity of living virtual experiences. There are many ways and techniques on how you can deliver such an educational experience. But first you need to consider the target audience, media form, instructional design, level of immersion, and duration of the experience you want to develop or use. As each requirement of the experience will directly affect the end product and learning outcome.

Apps and Labs: Teachers, students, and users can find a whole range of apps designed to give easy access to different forms of VR educational content. There are many different apps and Virtual Lab apps in Stores. You will find a resources of 'best of' apps list in the References Chapter.

4

4.2 Instructional Design and Storytelling in VR Digital Content

Instructional design is a systematic and reflective process to plan or design methods of instruction based on principles of learning in order to facilitate the construction of intended knowledge by the learner. Instructional design is important to ensure the learning processes achieve its optimization. Thus, good instructional design brings learning to life. The pedagogical perspective that forms the theoretical basis of VR-based educational storytelling system include the enhancement of constructivism learning; via storytelling and an interactive and explorative learning environment supported by VR technology. There are a few models and methods of VR-based educational storytelling based on various theories and learning principles to ensure the educational goals are best attained in a VR learning environment.

One model incorporates the concept of integrative goals, with the model for designing constructivist learning environments. The framework starts with the objectives and progresses to the support tools gradually. This is followed by scenarios/problems based on three integrated components: the problem context, the problem representation, and the problem manipulation space. The scenarios or episodes of the stories are constructed in this stage. The storyline experienced by each user will be different based on their navigation and interaction within the virtual world. This is followed by designing the necessary tools to support constructivist learning in this virtual world. This model is enhanced with multimedia design principles derived from the cognitive theory of multimedia learning.

To stay on the leading edge of this technological and educational advancement, designers of online learning will need to learn how to properly design and develop VR experiences for learners. They will need to learn how to carefully construct a VR learning environment.

It will be important to know how to apply the correct pedagogy, how to choose the right software and hardware, and how to apply the right instructional strategy to ensure learning.

As the field of instructional technology pivots quickly to VR, online learning developers must choose the correct strategy for creating the experience. Otherwise, learners will have a “cool” experience in the VR environment but not receive any tangible learning results.

The problem is that most online learning developers have never experienced VR and will have a hard time applying traditional instructional design methods to the VR space. It is important to avoid mistakes early in the process so designers do not end up creating bad VR classrooms. VR design strategies must go beyond traditional instruction to truly leverage the advantages of VR for learning.

4

4.3 Video 360º as VR Digital Education Content

Digital immersive content, is one of the main components needed to have amazing experiences for VR in education. There are several ways to create it. One way of doing this, is by using computer software (Unity, or Unreal) to create it. Thanks to the video 360º VR capture methods; we can bring the real world into VR.

The 360º video recording opens up a series of possibilities unimaginable until now. A new narrative, which in turn implies a series of new challenges and languages that require reimagining the creation of content from different perspectives. The sensation of going from a mere observer to participant in a story, and interacting in it in different scenarios; are just some of the possibilities offered by this new technology. The 360º video for VR, are created by filming all 360 degrees of a scene at the same time. Users can view the video from any angle in a pc, smartphone or VR headset. If the user turns and moves the device, the 360º video will follow. 360º videos can be recorded using a dedicated camera that contains multiple camera lenses embedded into the device, or multiple cameras set-up in a 360 physical format. The resulting footage is then 'stitched' to form a single video. This process is done either by the camera itself or by using specialized video editing software that can analyze common visuals and audio to synchronize and link the different camera feeds together.

Captured content can be separated into either monoscopic or stereoscopic 360º content. Stereoscopic 360º content allows you to have a 360º overview of the environment and creates the 3D effect with objects close by. Monoscopic 360º content lacks the 3D effect but is much easier to produce and easier to distribute.

Today it is not too complicated to create 360º video and photogrammetry for educational content, as these technologies are already available to the public today. Once you recorded and post-edited a 360º video, you can then publish it on an online video platform like YouTube, or you can build an interactive VR story on a platform like Viar360. Interactive stories give the viewers the ability to move from one 360º video to another and in this way control how the story unfolds. If you have used photogrammetry to capture a 3D model with one of the 3D scanning apps, then you can take that model and place it into a CGI environment with game engines like Unity or Unreal. Then, you can merge your videos recorded with your 360º camera and 3D models are captured using your 3D scanning app in Viar360.

When it comes to storytelling, sound in traditional cinema is used to support the visual field in front of the audience: cinematic sound is mixed in a way to prevent the viewer to look behind them. The story is always conveyed in front.

With VR/AR, the story can be conveyed in any direction, thus content creators must approach sound differently than traditional media. If you want the user to look in a certain direction at a particular point in time, sound can be used as a prompt (i.e. "look here" voice over, etc.) With the "look here" VO example, 3D audio is key to render the voice spatially so that the user can turn to look in the right place.

The system added a microphone array to capture 3D audio and 360º video simultaneously. One example is the VUZE+ that comes equipped with four microphones arranged on a horizontal plane which captures four channels of audio. The captured audio is then downloaded from the camera as four audio files to the VR Studio application where it is converted, using special code developed by VisiSonics, to an Ambisonics soundfield.

4 The camera uses four microphones arranged horizontally on a flat plane thus capturing sound only in 360º on the horizontal plane (front and rear.) While the camera itself does not capture audio above and below, due to the planar configuration of the microphones; using the RealSpace 360 (RS360) Cinema audio post production software developed by VisiSonics, users can add additional audio tracks in a full-spherical sound-field, including above and below.

5 VR/AR Educational Resources

Today, most students own a smart-phone, and this could be a big opportunity to start providing value at school. There are many educational apps available on both iOs and Android devices, and they are becoming more accessible to more students. These VR/AR apps will allow students to visualize and understand concepts that were confined to the pictures and texts in a textbook. Now, they have the opportunity to experiment and interact with the learning material in a way that improves their learning process and facilitates the comprehension.

The following Educational VR & AR applications will become a part of the Student Resource for the VRARA.

NAME	ON/OFF Line	SUBJECT	PLATFORM	RATING
Star Chart. Students can learn about constellations by aiming their phones at the night sky. There are additional features that allow students to interact with facts about planets and space discovery.	Off	Science	AR/iOS	***
Solar AR. An educational app offers you a new and fun way to experience Augmented Reality and learn about our solar system. With the planets flashcard image, this app will transform a simple planet image into attractive, animated 3D planets in real life.	Off	Science	AR/Android	***
Anatomy 4D. Study the human body with clear images that come to life. Ideal for biology students or anyone with interest in the inner workings of the body.	Off	Science	AR/Android	*****
Earth AR. See the globe from new unseen angles. Motion detection and zooming capabilities will make geography more interactive.	Off	Geography	AR/iOS	***
Amazing Space Journey AR. Discover the Solar System and explore the Sun, the planets and their satellites in stunning details. Take over time and space and observe the planets position and orbit.	Off	Science	AR/iOS/ Android	*****
Space 4D+ AR. Embark on a fantastic space exploration experience with Space 4D+. Space 4D+ is a collection of 37 educational AR flashcards about space including the solar system, planets, space objects, satellites, rovers, and space missions.	Off	Science	AR/iOS/ Android	****

5

NAME	ON/OFF Line	SUBJECT	PLATFORM	RATING
ISS on Live, HD View Earth Live. Do you like Space or Astronomy? Did you know you could see the International Space Station with your own eyes passing over you? And see Earth from International Space Station like the astronauts?	On	Science	AR/Android	*****
Flashcards. Animal Alphabet. Made for younger students, this immersive flashcard game teaches students words while bringing it all together with some colorful animal friends.	Off	Alphabet	AR/iOS	***
iCell. Is an interactive simulation that allows students and teachers to explore the inner workings of a typical animal, plant or bacterial cell.	Off	Science	AR/iOS/ Android	****
Quiver. Watch colored in creations come to life with Quiver. Through AR technology, 2D images become 3D and "walk" off the page. Ideal for younger students.	Off	Art/Paint	AR/iOS/ Android	****
Aurasma/HP Reveal. Engage teachers and students with excellent AR experiences using AR toolset.	Off	Development	AR/iOS/ Android	*****
InMind. Neurons and brain tissue have never looked more realistic. VR allows students to experience the journey into the brains in search of the neurons that cause mental disorder.	Off	Science	VR/ Cardboard	***
Cleanopolis VR. Fighting climate change becomes interactive. Captain Clean needs your help. Your mission if you accept it is to fight against climate change and make sure the city of Cleanopolis get rid of its CO_2 cloud.	Off	Science/ Environment	VR/ Cardboard	****
Sites in VR. Visit the famous landmarks in all their splendor. Examine the marvels of Islamic architecture, visit mosques, tombs, palaces of sultans, museums, inns, baths, castles, towers, old houses, squares, parks, nature, religious sites, ancient cities, space and other places with more than a thousand 360º panoramic images in high quality.	Off/On	Art/Culture/ Geography	VR/ Cardboard	***

5

NAME	ON/OFF Line	SUBJECT	PLATFORM	RATING
Acropolis interactive educational VR 3D. The world´s most famous citadel, the Acropolis of Athens, was built in Ancient Greece in the 5th century BC. Explore history with our interactive 3D scenes. Learn about historical sites, great works of architecture or events of the past. With our apps, learning becomes a playful experience.	Off	Science/ Geography/History	VR/ Cardboard	*****
Boulevard. Art classes can now be supplemented with visits to some of the world's best art museums. Students can tour art museums, interact with famous artworks and learn about the art, all thanks to the advancements of VR/AR/MR technology.	Off/On	Art/Culture	VR/AR/MR/iOS/ Cardboard/ Samsung/ Oculus/ Microsoft	****
Titans of Space. Titans of Space is a short guided tour of our planets and a few stars in virtual reality. Go for a ride through this authentic miniature Solar System. Great care has been taken to ensure a comfortable and thrilling experience.	Off	Science	VR/Cardboard/ Oculus Go/ Samsung Gear VR	*****
Apollo 11 VR. Apollo 11 VR is the story of the greatest journey ever taken by humankind. This VR experience is a recreation of the events, which took place between July 16th and July 24th 1969. Now, though VR technology, students can have a front seat in this VR experience.	Off/On	Science	VR/Oculus Go/ VIVE	*****
Google Earth VR. The world has so many beautiful and amazing places to visit. Google Earth VR is a powerful and amazing tool to learn geography, history and culture in an immersive experience. With Earth VR, you can fly over a city, stand at the top of the highest peaks, walk along new streets, and even soar into space.	On	Science/ Geography/Culture	VR/Oculus Go/ VIVE	*****
SmartEducationLabs. It is an innovative VR/AR ecosystem, where students will face with real-live problems with simulation-based training, prefaced with advanced classroom methods on process fundamentals. MySmartClassroom, MySmartDestinations, and MyStemLabs are the basic components of this VR/AR Mobile Educational Platform.	Off	STEM/Geography/ Culture/Art/ Futurism	VR/Cardboard/ Samsung Gear VR	***

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NAME	ON/OFF Line	SUBJECT	PLATFORM	RATING
EON Experience. Everything you need to access, create, and share complete virtual 3D learning experiences – all in one place. Students and lifelong learners can experience virtual 3D learning content free through a powerful EON Experience Player, join a global community of 3D learners, and earn tangible rewards for their 3D learning accomplishments.	Off/On	Stem/Art/Culture/ Dev	VR/iOS/ Android	****
Google Expeditions. Choose an Expedition and invite your class to jump right in. With a Google Expeditions kit, you will have everything you need to take your class on virtual reality tours: a tablet, virtual reality viewers, phones and a router to connect them all.	Off/On	Science/ Geography/Culture	VR/ Cardboard/ Daydream	****
Unimersiv. History comes alive with Unimersiv Platform. Students can explore and interact with different contents: ancient Greece, the Titanic or the Egyptian Mysteries.	Off/On	Art/Culture	VR/Cardboard/ Samsung/ Oculus/ Daydream/ VIVE	****
Cospaces. Is a platform for all ages and subjects. It complements traditional teaching methods by immersing students into a world where they can create, consume and connect with the curriculum on a completely new level, even through VR.	Off/On	Development	VR/iOS/ Cardboard	***
Tilt Brush. Painting from a new perspective. Tilt Brush lets you paint in 3D space with virtual reality. Your room is your canvas. Your palette is your imagination. The possibilities are endless.	On	Art/Culture	VR/Oculus/ VIVE	*****
Oculus. Is the platform for Oculus Rift, Go and Gear VR apps. Where user may find hundreds of VR applications for Oculus VR and Samsung VR devices. You need an account and on-line high speed internet connection.	On	Education/Games/ Entertainment	VR/Oculus/ Oculus Go/ Samsung VR	*****
VIVE. Is the platform for VIVE experiences. Where user may find hundreds of VR applications for VIVE HTC VR devices. You need an account and on-line high speed internet connection.	On	Education/Games/ Entertainment	VR/VIVE	*****

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NAME	ON/OFF Line	SUBJECT	PLATFORM	RATING
Steam. Is an entertainment platform where user may find hundreds of VR applications for Vive VR and Oculus VR. You need an account and on-line high-speed internet connection.	On	Education/Games/ Entertainment	VR/Oculus/ VIVE	****
Sketchfab. Publish, share and discover 3D content on web, mobile, VR and AR. More than 30 supported formats and you can embed everywhere. It is a huge library for educational assets.	Off/On	Education	VR/iOS/ Android/ Samsung VR	****
Streaming Services. Twitch, Jaunt, YouTube, Vimeo, Hulu, Netflix, and TiVo are all streaming providers who either already have or will have an interest in streaming VR content. There are some apps available from the Gear VR Store, offering subscribers access to 360-degree videos from content providers such as Discovery, National Geographic and many others.	On	Education	VR/iOS/ Android/ Samsung VR	****

6 Case Study 1

Carlos J. Ochoa www.onedigitalconsulting.com

Learning Resource Centers in MOE Schools (United Arab Emirates)

SmartEducationLabs in Education. Carlos J. Ochoa (CEO ONE Digital Consulting).

The Ministry of Education of the United Arab Emirates is implementing an innovative Learning Resource Center Program in MOE public schools from 2016 to 2018. The aim of the program is to provide a flexible, technology-enhanced space that supports creativity, innovation, and curriculum; improving the teacher's skills and serving as a focal point in communities. Each Learning Resource Center is equipped with Smart Interactive Screens, Sound Systems, Tablets, Laptops, 3D Printers, Mini-Robots, VR/AR devices, games, e-content and educational apps for VR and AR.

Project Definition: The original idea and concept designs were created during the Gess Educational Congress in Dubai in 2014; in a new innovative framework called "Schools of the Future". The evolution of the project via an Interactive Smart Lab was a very first approach to experiment with the integration of new technologies to start Project Based Programs. In a new open space, teachers design activities connected with real-life problems and students need to resolve the issues with the help of methodologies and technology. For example, students work autonomously and discover how to apply specific technology applications in each facet of the problem-solving process. In the end, a student uses elements of mastery-based learning blended with route trial and error experiential learning.

Unlike existing media and teaching tools, the Virtual Learning apps complement text and pictures with a 3D experience that truly engage students. It provides students with the context that enable them to build mental models and better understand STEM issues. Moreover, these activities are engaging and give the students the opportunity to use agency for their own learning outcomes. In another example, students can now take a field trip to Ancient Civilizations via a VR teaching tool. Students have the possibility of visiting Reconstructed Ancient Cities and studying added value information around those places. To put into practice, we defined a toolbox of activities to help teachers understand how to apply this technology in the classroom:

- 3D recreation of World Scenarios.
- 3D recreation of Virtual Objects
- 3D recreation of Human Body Parts
- 3D VR/AR experience across the Universe and the Human Body
- Virtual STEM Labs
- Exhibition and gaming technologies

Interactive applications can be focused on education, gamification, information, and exhibition. Some of the work realized are applications of great relevance for students:

- Multimodal: Students see, hear and touch.
- Collaborative: Face to face teaching and learning
- Kinetic: Full body interactivity in physical space

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As a pioneer project, we started with the very first version of Samsung Gear VR and Samsung S6 smartphones for VR/AR and Tablets for AR experiences as well. We provided Oculus Rift pc based educational content too. At the very beginning, it was a tough experience, because this new technology was in a very early stage. In addition, we needed to provide a lot of support for the teachers.

The success of a complex and innovative project like this one, demands the engagement of a reputable, seasoned and qualified team of professionals. The Teachers training program is a key success factor for the project, including workshops, seminars and community support. We know that teachers play a key role in adopting the technology. So, teachers need to be enrolling in this process as main actors and intrapreneurs. They need to become change leaders using their ambition, professionalism and subject knowledge as key contributions. In that way, we developed a specific Teachers Workshop for VR/AR to integrate the technology into an open LRC. Lastly, we developed a methodology to implement and evaluate the project.

Smart Education Labs Methodology ©.

- Definition of the scope and objectives
- Definition and integration of infrastructures, devices, and contents
- Teachers workshops management
- Content management

Starting class activities:

- Introduction to devices and methodology,
- Class in progress: Introduction to Units
- Sharing experiences
- Lessons learned: For 2 years, we have had many lessons learned from the project and we were making changes as needed during the different phases of implementation.
- Need to provide a specific example of at least one lesson learned*

We also created a platform for technical support, a news magazine about the most critical issues related to VRAR evolution, tips & tricks, and manuals to resolve technical issues.

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6 Case Study 2

Dave Ternent and HumanEyes. www.humaneyes.com

How teacher´s use VR to enhance students' Learning Experience. Stow-Munroe Falls School District (Stow OH).

Dave Ternent and HumanEyes.

"I want to prepare my students for the world they are going to live in"

Dave Ternent, a 7th grade Stem teacher, teaches VR creation.

He has a Master's degree in Instructional Technology and is always looking for new devices or software that will enhance his classroom lessons and the student's learning experience. Dave teaches at Kimpton Middle School, which has about 900 students, the majority of whom are taking part in the STEM program.

Here is how Dave integrates VR into his classroom: The STEM class is divided into 2 tracks. The first track is the 3D Modeling track where students learn about 3D CAD Modeling, coding, 3D Printing, and Robotics. The second track is the VR Track where students learn what VR/AR/Mixed Reality is, they get to use different headsets including the Oculus Rift, HTC Vive, Microsoft Hololens, the Unity game engine, 360° cameras, and how to create their own 360° app. The students get to decide which track that they want to take.

"I want to prepare my students for the world they are going to live in, especially in the design and manufacturing workplace. Not what is around now. 3D and VR content is how companies design and create their products."

The parents and Dave's colleagues love it and are thinking of new ways to use the camera! Sports teams want to use it for video analysis of practices and players, 360° video of school plays, 360° video of students writing and directing skits, where the camera is a character which is an idea that came from the Drama teacher. That is just a few examples and the list is getting longer every day.

Dave does not stop with STEM: "In the long term, my plans for VR are to expand its use! Another teacher uses it in rock climbing to show his special needs class. Kent State University's Public Health Dept. wants to work with us to use the cameras for filming, and then GPS tag the footage of areas where public health concerns occur."

Dave chose the Vuze VR camera because of its durability and high-resolution. He has used it for sports practices and his students use it in his class to create their 360° VR field trips. They use Google cardboard, Oculus Rift, HTC Vive or Microsoft Hololens to experience the field trips.

The following is some example 360° footage of volleyball practice. Coaches love it as a teaching tool because they get to see all sides of the action at once. They have asked Dave to film more sessions (time permitting)!

"The Vuze VR camera really meets my expectations and even exceeds them!", says Dave. "The software is so versatile and easy to use. Creating 360° content, with 13-year olds doing the filming and editing, is simple and gives you a professional looking product. Made by 7th graders!"

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Media:
https://youtu.be/Cnc6dhOHt4Y

6 Case Study 3

Julie Smithson julie@metavrse.com

Coding in VR. Toronto (Canada)

In celebration of Canada's Coding Week in Canada, Phase 1 of Coding in VR launched together with MetaVRse, Ladies Learning Code, Primitive, & House of VR all located in Toronto, Canada. On Tuesday, June 6th, 2017 local Grade 7 & 8's (12-14 years old) arrived at the House of VR to experience Coding in VR for the first time in Education. The day was full of learning from the kids and for us as developers understanding how the kids experienced the program and the world of VR. We were excited about the possibilities in developments to come and look forward to expanding the lessons of an Educational VR Curriculum into classrooms around the world.

Every child learns through their own set of wiring, their own medium of taking in information. Sometimes it is auditory and sometimes it is visual. Sometimes it is slow and sometimes it needs to be fast. Coding in VR provides a visual plan to the sequence of a theme and seeing it in VR makes the sequence more natural to understand.

The Process: Coding in VR uses JavaScript and a visualizer to connect the theme used in a virtual space. The Phase One theme used Mammals and the code that makes them what they are. Inside the HTC Vive, they are connected into the Mammals sequence to see a whale, cat, and dog visually to the corresponding picture. For our next phase, we hope to integrate a guided tutorial to teach about the similarities and well as further development into themes as we engage the students into a world they have never seen and some may not understand yet. We had 10 HTC Vive units setup with kids rotating through 5 lesson periods of 15 minutes each. Each student was set up and then by way of connecting from Los Angeles, California, A leader from Primitive dialed in to provide step by step instructions to the group of students inside the coding room.

Follow up Notes:

Coding in VR
Built for Schools Elementary to High School

- Gamify the levels
- Different Themes
- More Instructional
- Eye Gaze Instructions / Help button / Next Steps
- Start 5 Levels
- Junior Coding in VR
- Levels from Mammals, Dinosaurs, Planets, Amphibians, Plants,
- Coding in VR - Level 2
- Levels Periodic Table, more intense learning. (Primitive to dev with LLC)

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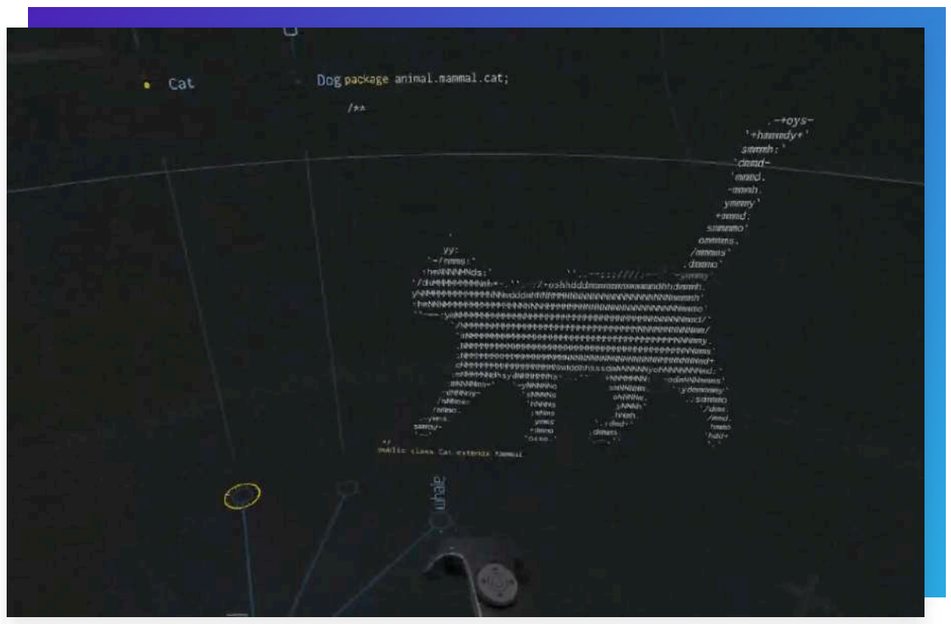

360° Photo of Representatives from Canadian Government, MetaVRse, Ladies Learning Code & House of VR

Key Messages:

1. Empowering your Kids to know about Coding & VR
2. Stay on track with kids learning to keep the pace of innovation and Build the Skills for tomorrow
3. Immersing your kids into something they are interested in
4. Teach your Students immersively
5. Teach your Students the platform they will live from
6. Immerse your kids in a Virtual World of Teaching
7. Digital applications are one of the primary interests of students
8. Introduce into Parent Councils to seek home growth adoption

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Other notes:

- Can a program be used on the new GEARS? With remote control?
- And maybe more intense training inside the VIVE
- GOOD WILL INITIATIVE is that all equipment in the year term is donated to a 3rd world country/ organization to bring technology to 3rd world country
- Status: Due to minimal adoption in VR, this application development was put on hold until further capital could be applied.

More Info:

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6 Case Study 4

Mfon Akpan makpan@nl.edu

Incorporating VR in the Accounting Classroom. National Louis University (Chicago)

The 360º video or immersive video allows the watcher to view in every direction of the video. The viewer can view the video from a desktop or mobile device like watching a YouTube video. The 360º videos can also be viewed with VR goggles for a more immersive experience. The students view and interact with the 360º videos and simultaneously answer instructor questions. The 360º videos also help to visually reinforce general business concepts.

The VR technology can be used to take students on business field trips, give visual examples of accounting concepts (inventory, cost of goods sold, sales), and be used as a tool for face-to-face classroom engagement.

The VR technology can also help to foster an asynchronous environment in the online classroom. The immersive properties of VR can move an asynchronous form of communication closer to contemporary experience.

The VR environment creates a more profound student impression and memory. This long-term memory of the virtual experience is what helps to increase knowledge retention.

The use of 360º video creates little or no cost burden for the students to access and utilize the technology. The use of YouTube to host the 360º videos provides an open and easy to use platform for the students to access in and out of the classroom, via desktop computer, laptop, tablet, or smartphone device. The medium is not intrusive as there is no need to use a headset.

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The use of a headset such would enhance and increase the immersion of the experience.
If the instructor is creating his or her own content, there would be the cost for the VR camera and any editing software. The instructor also has the option to utilize a plethora of free content on YouTube, Facebook, and VeerTV.

The best practice is to keep things simple and streamlined for the students. Access to the technology should not be intrusive. The use of the 360º videos enables students to access the virtual content easily via social media outlets. The students have the option to access VR content via smartphones, personal computers, and tablets; with the potential to upgrade the experience using VR headsets such as Google Cardboard or other VR headsets.The use of the 360º video also gives the students valuable exposure to emerging technology. The exposure to VR technology and its use will help students as they move forward into the job marketplace and society.

More Info:

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https://youtu.be/JHCdSlr6eEI

6 Case Study 5

Steve Bambury sbambury@jess.sch.ae

JESS Dubai

JESS is a group of three schools, two primary schools and a secondary. In the primary schools, we have a bank of Viewmaster headsets and iPod Touch devices. In the Secondary, we have a bank of Bobo VR Z4 headsets and students use their phones in them. We also have a BYOD iPad scheme in the KS2 years of each primary school and banks of iPads in KS1 and EYFS. In Secondary we have a Surface Pro 4 scheme in KS3 and an open BYOD policy in the years above this. We also now have three HTC Vives thanks to the local HTC team (though we are still looking to source the laptops to run them, and currently I am still utilizing my own.)

So why am I listing all of our hardware? It's to do with how we integrate VR using the technology available to us. Like most schools we are generally not in a position to provide 1:1 VR, with the possible exception being the Secondary school using the mobile VR headsets and harnessing the BYOD phones that the students have in their pockets. So how can you begin to integrate VR with a limited number of headsets available - and do it in a meaningful way?

The model that I have been utilizing involves harnessing multiple platforms and devices in tandem with each other. First I coordinate a date with a year group and work with them to identify a current area of study that we can enrich using some VR. I then research potential apps or VR content that could be harnessed and share the options available with the team. We then implement a plan focusing on the learning that will take place. This part is crucial. Implementing VR in a meaningful way is impossible if the focus is on the technology and not the actual learning taking place. As such I will generally tailor an activity around the experience.

A recent example took place in the Year 5 department of one of the primaries. Their topic was Ancient Greece, so I began hunting for content. At first, I thought I'd struck gold with the brilliant apps from Lithodomus who had Athens VR on iOS and the newly launched Acropolis VR on the Vive. Ultimately, I decided against using them, despite how good there were, as they contained a fair few historically accurate statues... i.e., fully naked men and women. Living in the UAE and knowing that I'd be working with groups of 9-10-year-olds, this seemed like it had the potential to lead to issues and I returned to the drawing board. I did like the idea of exploring the Acropolis though, and so I focused on that in particular. University offered an Acropolis experience within its platform which I could access on the Vive but not on the iOS devices. In the end, I realized that the answer had been provided to me by our headsets; the Viewmasters come with a replica of the old style Viewmaster reels and one that worked as a trigger to launch an experience within their Destinations app which just happened to be of the Acropolis!

With the apps sorted I then built the activity that the VR would frame. In this case, it became a collaborative research task. Students would work in groups of six to explore the Acropolis and note down their findings on a large sheet of A3 paper. I gamified the experience somewhat too by telling the groups that their challenge was to collate the most detailed set of notes and that the winning team would receive a prize. This lead to an excellent discussion of tactics and teamwork. For example, if they didn't communicate properly to coordinate their search for information, they'd all end up finding the same facts. In practice, this lead to calls of "Ok I'm in the theatre of Herodes, someone else heads to the temple of Athena" and the like.

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Each group came to me for around 20 minutes, and from each group of seven students, I rotated 2-3 onto the Vive during their time slot. The initial student I selected myself based on my knowledge of the kids and how competent they were with technology. The subsequent students earned the spot by putting in the best effort with the research on the mobile viewers. As such the use of the Vive became an incentive to engage fully with the core task. I also highlighted how important the role was if you got to use Unimersiv on the Vive since there were additional facts available within this app that not every team would locate, so it gave your team a better chance of winning if you could find and include them.

Here's a short clip I put together for one of the classes to share in their assembly. Note: I couldn't screencast from University so the clip only features footage from the ViewMaster app.

One of the great things about the setup of the two JESS primary schools is that each year group have a central area which is mostly an additional classroom-sized space that connects the actual classes. These make perfect staging areas for me when I host these "Immersion Events" (as I have dubbed them.)

That being said, not every school would have access to either space or an additional specialist teacher like myself to facilitate such a session. If this is the case, and you need to engage the whole class simultaneously, my suggestion would be to look towards platforms like Expeditions or even YouTube for additional 360º content which can work on a tablet as well as a headset. As such, an activity like the Acropolis one detailed here could have been supplemented by an additional resource that works on a set of iPads or other similar tablets. Students could rotate between the various platforms available either using a free-flow dynamic or as a carousel.

More Info:

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6 Case Study 6

Rutgers Preparatory School www.rutgersprep.org

Rutgers Preparatory School in Somerset, New Jersey, United States.

Using the HTC Vive in one of the traditional computer labs remodelled to be a Tech Lounge.

Students are encouraged to relax and use equipment, including Vive. “Playing” with technology is a great way to have the students feel comfortable with each device. The Technology Administration staff purchased and maintained the Vive with the addition of programs requested by teachers.

Google Expedition class set.

All students grades K-8 have used VR and AR when they meet with the librarians regarding a thematic unit of study. Youtube 360º videos are used to supplement. TimeLooper is used to support history lessons. It is important to note that the original ten Asus devices worked with TimeLooper, but the newer Google devices did not work until TimeLooper pushed out an update that did not require a GPS sensor. It is a good idea to use the device to search the Google Play Store to see if the apps you want are available in that version. The teacher tablet in Google Expedition can be used for supporting the teacher with a lesson. It is essential for the teacher to watch the screen of the tablet to see if students are moving too quickly in the environment and risk dizziness. Having the content available for the teachers is a great way to support a novice.

All students K-8 participated in Google AR. Teachers prefer the AR environment over VR for the youngest students. Octagon cards are used with young students with iPads. Teachers have a Virtual-tee for use in the classroom. We are working on the display of the teachers’ devices to the class through Apple TV. Teachers are investigating the use of Froggipedia to practice for dissections or as a replacement for dissections.

Two classes in grades 5 & 8 are using Ricoh Theta for 360º filming to present “A day in the life …” Students start the process with a review of 360º videos for technique and content.

Happy Atoms are used in Chemistry class to replace ball and stick models. Lesson plans supplement classroom activities and generate new ideas even for experienced teachers (Students want an AR version of the electron cloud).

The Rutgers Prep school crest is now a Thyng target. Dark ink on a white background and white ink on dark background images are both loaded. You need each image if they exist. We noticed the issue when scanning the white ink on the dark background (on coffee mugs and mouse pads).

All K-8 students went home with Rutgers Prep a branded VR viewer after their first VR experience. We will try mini-VR viewers like Homido to see if it is better for students. VR can be isolating for the students and teachers want students to stay connected to the class. Mini VR viewers can be used in class for short VR clips and return to non-VR work. Mini VR viewers purchased through Geek Tech Branding will be given away at Admissions events and Girls Exploring Technology workshops.

Each school needs an R&D budget. VR&AR are changing so fast that it is difficult to budget for expenses before the item is outdated. It is also important to find the financial flexibility to explore new options. “Little bets” can be explored while larger, significant purchases can be allocated in a traditional budgetary process.

6

More Info:

Rutgers Preparatory School
https://www.rutgersprep.org/academics/academic-technology

Media:
https://youtu.be/tPwSPEmGlvc
https://youtu.be/QJ8NXHk9uLM

6 Case Study 7

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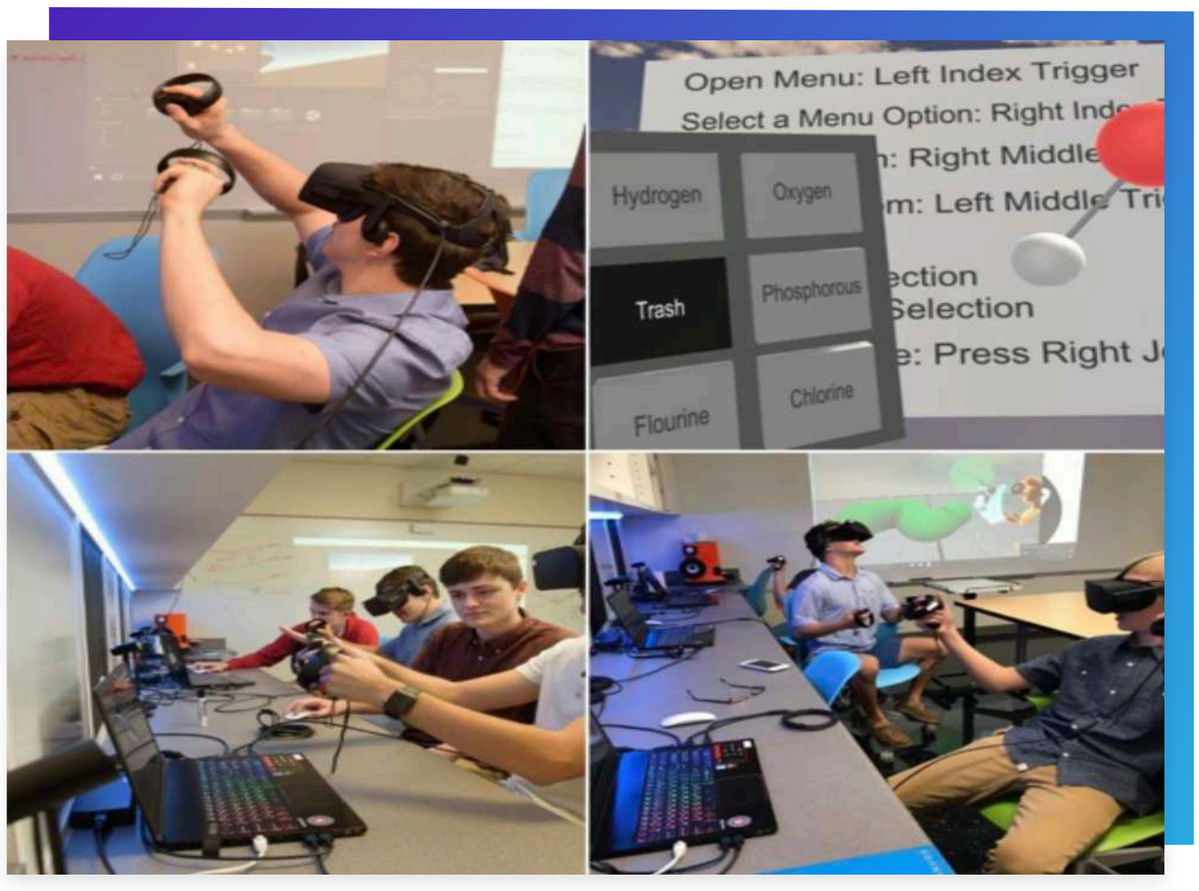
Implementing a VR creation lab in high school. (Tampa Preparatory School).

Some surprising benefits included branching out beyond computer science into areas like chemistry and physics. This is an example of the amazing things students can do if given the opportunity to pursue their passions. They need time, space and resources as well as support and encouragement. Many times educators' egos get involved and we think that we must be the sole source of knowledge and experts in a particular subject, which can impede growth. It's the process that's important. The outcome of having these student created science apps was just gravy. The main thing is that they're learning coding, 3-D modeling, game development, collaboration, and design thinking. By the way, the app selections where student ideas. For example, one of the students was having difficulty visualizing molecule binding in chemistry. Sometimes a molecule might be behind another in Z space which is difficult to draw in 2-D space on paper. VR is the perfect solution because it's a 360º environment where students can rotate, zoom and move around to see the entire structure. As for pre-made applications, we are using Medium, a virtual-reality sculpting app, Nature Track for mindfulness training, Calcflow for vector calculus and many others.

Actually, the entry point into VR creation was less expensive than many schools are paying for mobile VR kits but they are "one trick ponies", primarily for solely immersive experiences with very little student interaction and no creation options. Creation is the highest level of learning. Each VR creation station cost us around $1800 all in. Keep in mind that the lion's share of the cost was the laptops, which are also used for other functions like 3-D modelling, AutoCAD, etc. So if you already have a computer lab with decent video cards on the computers, the cost of entry to VR isn't that bad.

The cross-curricular pollination of VR has come as a pleasant surprise. We started our research into what virtual/AR might mean for education in the fall of 2016 with Google Expeditions. Then we moved to student creation of VR environments with Cospaces, primarily in the middle school. In November 2016 we purchased an Oculus Rift and mounted it to a mobile Conen display with an Epson Brightlink projector so that we could bring it into the classrooms. In the process, one of our computer science students came up to me and said "Mr. Lewis do you mind if I try to create some VR apps using Unity?" and it really took off from there. The lab was a student-driven initiative.



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The creation of the six-station lab has had some surprising outcomes. Now we have a student VR Creation Club and next year will have a VR/AR creation class. In addition, this lab has led to a new STEAM initiative. We have one of the art classes creating virtual sculptures with an app called Medium on the Oculus Rifts. They can save these sculptures as 3-D models and either print them out on the 3-D printers or send them to the computer science students to use as assets in their Unity projects. It's a great way to expose art students to 3-D modeling technologies. I knew that art has a lot of potential with VR as a new method for creation, so over the summer I gave an Oculus Rift to one of our art teachers to use and she now uses it in her classroom with her students.

My advice for schools is to just start looking into VR in any way they can that will fit into their budgets and school culture, this can be with anything from Cospaces to Unity 3D. Even just 360º image and video creation with Thinglink has the potential for a lot of cross-curricular use.

I really wouldn't do much differently. We reclaimed a storage room in the library that was filled with old assets and built a creation lab dubbed the IDEA Lab (which stands for"Innovate Design Explore Apply". The lab has all of the VR laptop stations connected to an Epson projector which can display a 7-foot image of any of the laptop screens onto a Walltalker dry erase wall which makes for a great teaching space as well.

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6 Case Study 8

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The Future of Education. Lethbridge College (Alberta, Canada).

The need for education and professional development opportunities will always exist. Shrinking budgets and time restrictions have proven prohibitive for some organizations to provide quality education opportunities. Webinars have been the solutions for many organizations. Individuals could access experienced educators on various topics through a combination of talking head videos and slides. This approach from an education perspective has many flaws. Some of the flaws include the lack of engagement, not feeling connected, and not being in the present. VR provides an experience that overcomes these flaws and provides an immersive education experience.

On April 26th, Lethbridge College and the VR/AR Association presented the world's first full-day conference held completely in VR. The conference was about virtual and AR and featured Alan Smithson, Alex Katzen, and Cathy Hackl as keynote presenters. Individuals from the Alberta VR/AR industry and abroad spoke, including Steve Bambury a leader in the area of emerging technologies for use in education. There are many social VR platforms on the market, but the one that was chosen and was the best fit was Rumii by Doghead Simulations. This platform provides a social VR experience while providing enterprise and education features, such as 3D model integration, interactive whiteboards, screen sharing, video playback, and more.

Alan Smithson (CEO/Co-founder of MetaVRse) in Rumii

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6 Case Study 9

Alan Smithson CEO/Co-founder of MetaVRse

Rumii

Where webinars fall short, VR shines. When you're in VR with a presenter, you feel that you are really in the same room with them. You are immediately transported from your office to a lecture hall. The avatar expressions and movement, combined with 360-audio truly make you feel that you in the same proximity as the presenter. When I was in Rumii with Alan, I could feel his passion for VR/AR, I could sense his excitement, and I could see his personality shining through. All of this would have been a subpar experience in a webinar.

While the conference was primarily focused on being presented in VR, many people still do not have VR headsets. As such, the event was also live-streamed on Twitch.tv, providing absolutely everyone to participate. Those watching Merging Realities via the Twitch stream also had the option of asking questions of the presenters via the chat feature of Twitch. These questions were related to the presenters in VR to be answered.

Merging Realities by the Numbers: The interest in the VR-powered conference across the globe is represented by the infographic below. There are 188 participants registered for the event from 84 cities and 16 countries.
Some additional statistics that indicate not only the success but interest and demand for an event such as Merging Realities are below:

- Not including the presenters, there were 50 people in VR at some point throughout the day.
- There were 712 live views on Twitch, accounting for over 12,000 minutes of the conference watched.
- The event hashtag, #MergingRealities2018 had almost 3 million impressions, reaching just over 600,000 people.
- What Merging Realities Taught Us: It's clear by the numbers along that Merging Realities was a success. Even though this event was hugely successful, it had its share of problems. Merging Realities will happen again and the lessons learned below will help the event and future VR conferences are more successful.

Schedule: having concurrent speaker sessions for a VR conference may not be the best idea. In traditional conferences, concurrent speaker sessions is the norm. But there is a difference. With traditional conferences, you often need to physically move to view different sessions. This movement is often accompanied by bathroom breaks, snacks or visiting. In VR, the motivations to get up from one speaker room and go to another are not as strong.
Speaker Preparation: when preparing for an in-person speaking session, speakers often will rehearse their presentation many times and often review the technical setup available where they are speaking (eg. Internet, audio, projector, etc.). This shouldn't be any different with VR presentations. In fact, the preparation should be more. Whenever a new technology or a new application of an existing technology is used, the chance or errors occurring increase. The best way to mitigate this risk is to practice, practice, practice. Not so much practicing your presentation (although that is a great idea), but rather practicing using the technology.

Speaker Support: even if speakers in a VR conference practice using the technology, there may still be issues that arise during the day. When issues arise during an in-person conference, the AV technician for the hotel is called, and the problem is fixed. But when you are in VR whom do you call? It was evident that establishing a dedicated backchannel for speaker support is a must. Ideally, this support channel should be within VR because if something is going to go wrong in VR, you will need to be able to troubleshoot while in VR.

6 Time Zones: Merging Realities had people from 16 different countries attending. One minor detail, which went overlooked, caused a bit of confusion. In-person conferences are usually in a city and the time zone is consistent. With a VR conference, the time zones could be varied. It's critical to ensure that in every communication, the time zone is clear and possibly provide additional time zone converter or various time zones on your event registration page. 4 use cases on:

1. Digital Media
2. Nursing
3. Merging Realities (education use case that shows you can teach in VR)
4. Data visualization (Steven/Univ of Calgary)

Merging Realities Presented Feedback: Alan Smithson provided one of the Keynotes for Merging Realities and experienced several components that made the presentation as real as it could be with the technology and ways to improve the experience to immerse the user further into the Virtual Classroom.

Engagement in the lobby to understand who else is in the room and ready to learn. A social setting requirement to be able to engage in the class and know where everyone is from and their intentions of being present. Games are suggested, An Arrival board like the airport for people to review and see who is there.

At the start of the presentation, the presenter should provide a brief overview of the controls and capabilities in the room to ensure everyone understands the actions available and how to interact. Also, provide rules of engagement (ie. Muted audience, Q&A signals etc)

When presenting in VR - Voice is the captivating motivator. A strong and entertaining voice leading the presentation to educate the audience until the avatar movements are developed into realism is the key to maintain immersion and education retention.

Confidence Monitor is Key: From the presenter, making the room as immersive as standing on a real stage is important to make the presenter feel like they are presenting.ie.lack of a front screen monitor means the presenter needs to watch the screen with an audience to run through slides, thus the Avatar back was to the audience until he turned around. Entry of new users chiming in is distracting and should be silent not to disturb class or presenter.

Avatar creation accuracy to include full body, with legs, feet, arms, and hands will expand the body movements into further immersion. Developments of real-life Avatar insertion will be key to deeper realism and immersion. Reporting on Presenter engagement from an audience is key to understand the full immersion experience and lessons for a presenter for next time.

More Info:

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Media:
https://lethbridgecollege.ca/news/student-success/students-lead-charge-groundbreaking-virtual-reality-conference

6 Case Study 10

Daves Room

Pacha's Pajamas

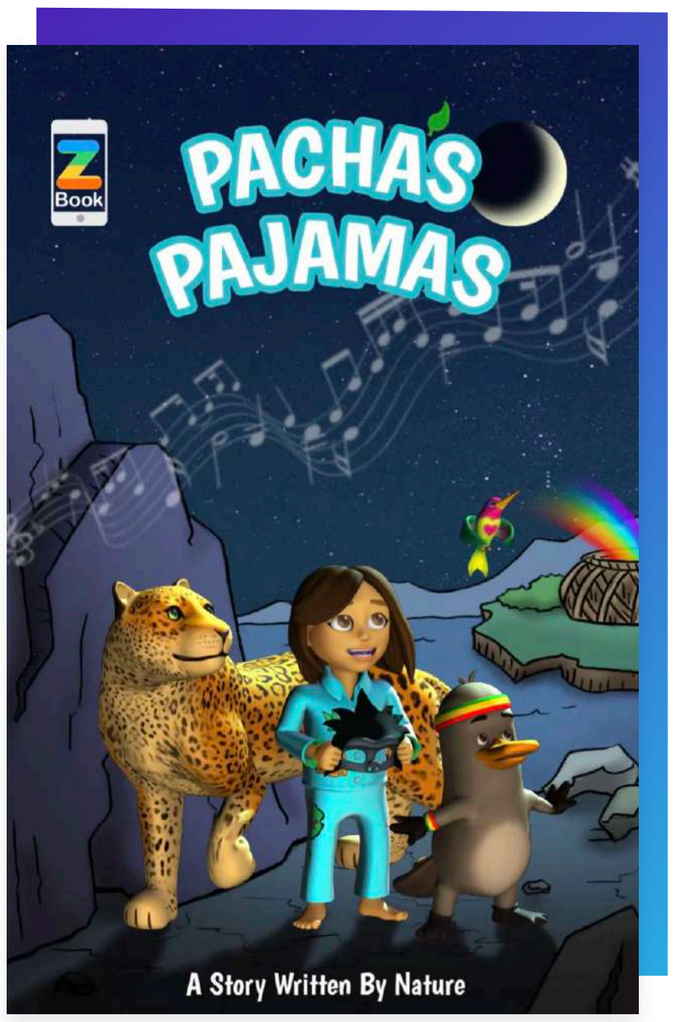
"Pacha's Pajamas: A Story Written By Nature" is an AR book. It is a young reader book, written for 8-10 year-olds. The customers are parents, teachers, and librarians in the United States. Over 3000 books have been sold at events, bookstores, online, and to schools. Hovering an AR app over the black and white images in the book brings the characters to life with 3D animations. There are 80 illustrations that come to life. The app was built using Vuforia.

Pacha is a little girl awakening to her immense gifts and bringing them to the world. Pacha's imagination is bigger than the Andes Mountains - homeland of her ancestors. When she goes to sleep, the characters on her pajamas become her guides on dream adventures to learn more about herself and her connection to the natural world.

In the first book in the series - A Story Written By Nature, her pajamas are covered with plants and animals - a whale, tree, jaguar, mushroom, pebble, and hummingbird.

The day before Earth Day, Pacha's magical pajamas carry her into an epic dream where she is the central player at a nature festival to save the planet from destruction. Pacha awakens with the inspiration to show the world that We Are All Connected.

The book series is based on the following formula. Each book has a new pair of pajamas. When Pacha goes to sleep, she goes to the dreamworld on her pajamas. The characters on her pajamas guide Pacha on a dream adventure to learn more about herself and the dreamworld on her pajamas. Pacha brings what she learns back to her waking life. The first book is about nature and the pajamas have a hummingbird, whale, tree, jaguar, and mushroom. It was published by Morgan James Kids out of New York and it is the first of its kind animated book that comes alive with AR. Hovering the Pacha Alive app over the illustrations brings them to life with 3D animations that appear to pop off the page and feature celebrities including Cheech Marin and Mos Def.



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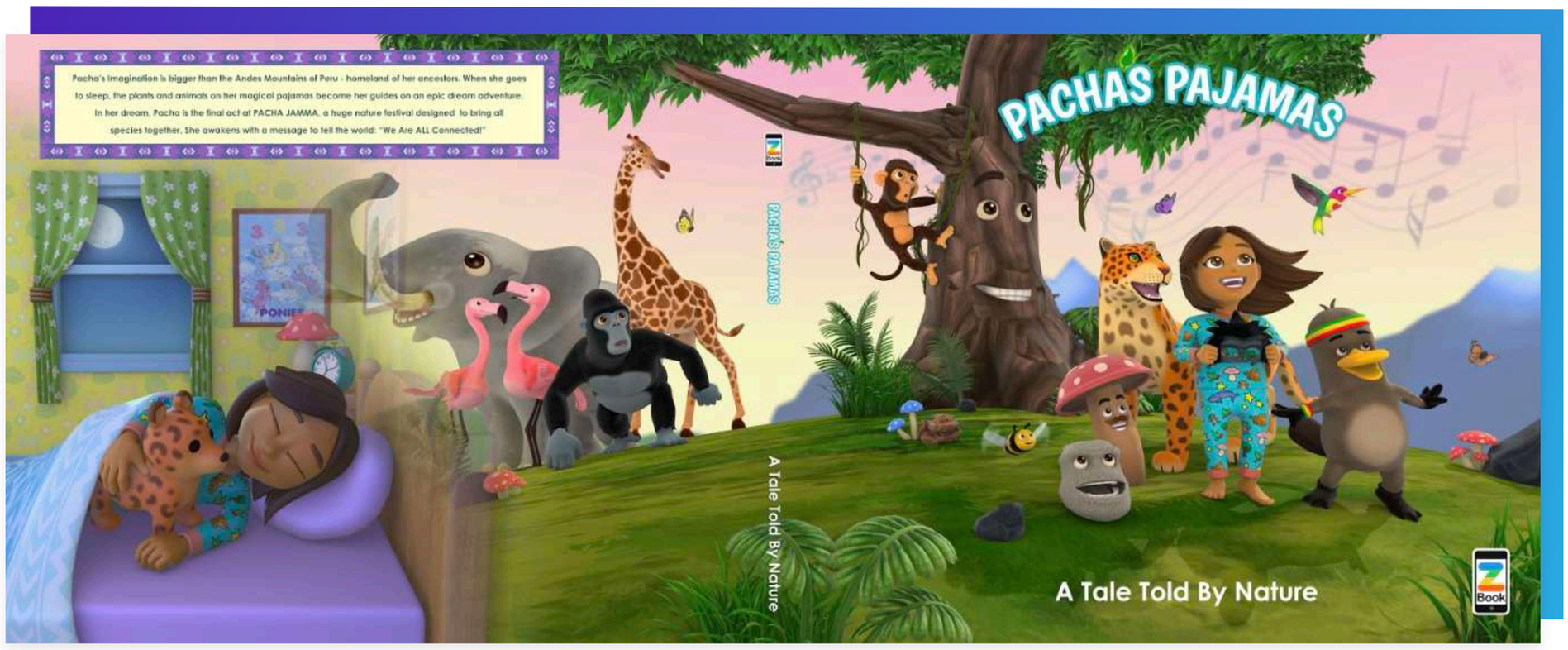
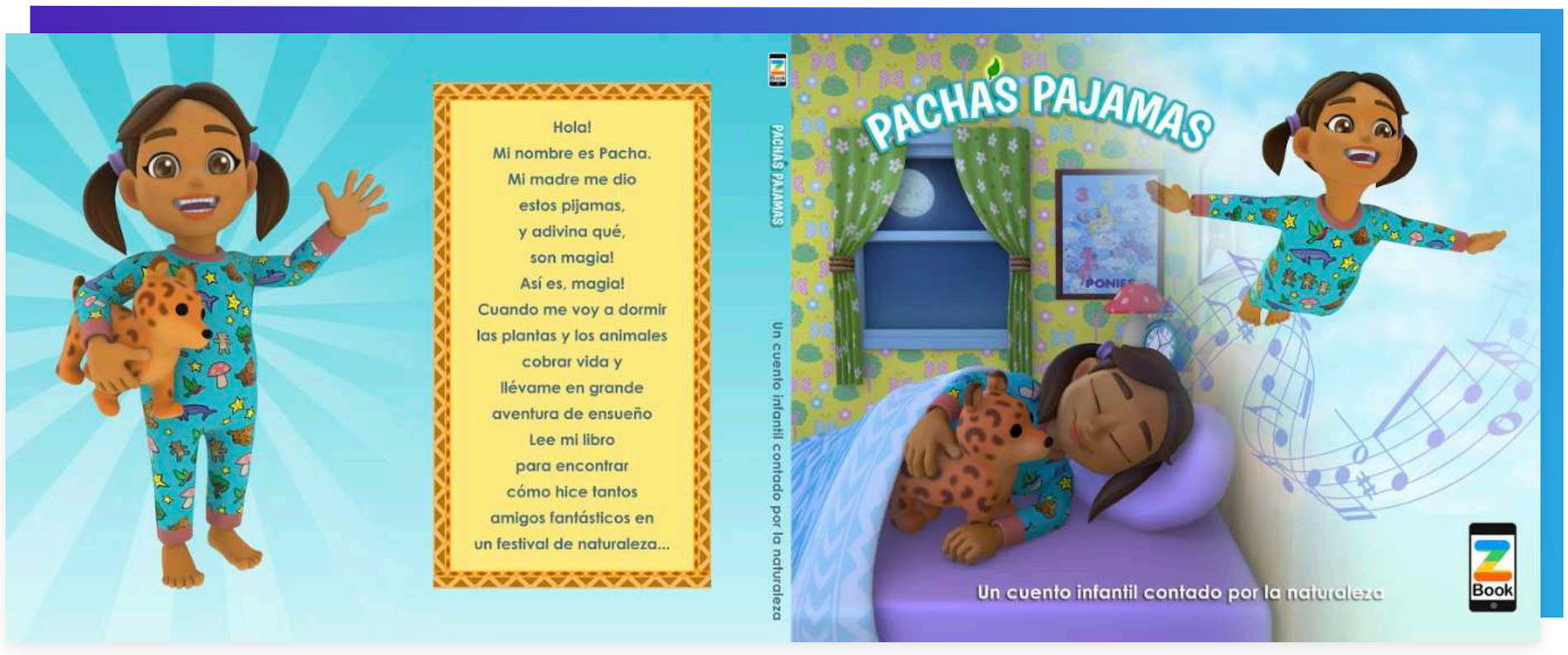
The first book in the series is written for 7-12 year olds and has a Lexile score of 930. The book can be read to younger children of 4-8 year olds. The book has fun facts, a dream journal, song lyrics, and school curricula.

Based on Leiden University research, interactive elements such as multimedia functionality that are directly tied to the story; improve reading comprehension and expressive vocabulary.

Hence, we chose not to have any interactive elements (e.g., games) in our AR book and focused on multimedia AR experiences directly connected to the story or the animals in the story. We chose to use relatively short AR experiences; 93% of the AR experiences are less than 30 seconds.

We are also making younger children versions of the first book. One is a full-color early reader book for 6-8-year-olds and the other is a picture book for 0-5 years olds. These books are different in that the images in the book are based on 3D character models with some 2D graphics. This will enable the books to come to life seamlessly. We recommend that parents not allow children less than two years old to use AR. The response from parents and children to the first book has been great. We have videos of people's reactions when we first show them the AR. They are hilarious. It is safe to say that people are generally very surprised and delighted. At events, usually, a significant percentage (20-40%) of the families who see our demo will purchase the book. We have found it challenging to sell the book online since the vast majority of people have never heard of an AR book.





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Lessons learned:

- Do not underestimate the need and challenge of educating the market about augmented reality books
- Write and publish multiple titles of a series in relatively quick succession
- Be mindful of how you incorporate interactive elements in your AR experience to ensure that it does not detract from the educational aspects of the book

More Info:

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6 Case Study 11

Carlos J. Ochoa www.onedigitalconsulting.com

Schools of the Future. Miramadrid School. (Spain)

"The world as we have created it is a process of our thinking. We cannot change it, without changing our way of thinking" Albert Einstein.

The implementation of new immersive technology programs at schools requires a previous teacher´s training and qualification process. For this, within the "Schools of the Future" program designed by ONE digital consulting, we launched an initiative to identify Educational Centers that would be interested in entering the world of VR / AR. Miramar School in Madrid was one of the three centers selected in the program and for several reasons that we want to highlight: Management committed to innovation, an educational project that covered all educational cycles, and a teacher at the national level, participating as an authentic driver of this initiative, David Montejano.

For the implementation of the Schools of the Future program, we set several objectives in order to draw conclusions about the suitability of the model and technological adaptation along with its impact on learning processes. But the key element on which the whole project depended was the training and qualification of teachers, as real drivers of change. The Main objectives of Schools of the Future Program were the following:

- Analyze and evaluate the initial gap in the teaching staff
- Identify and train project leaders
- Start up the VR / AR platform, adapting the ecosystem to the requirements of each center
- Evaluate VR / AR technology in the classroom
- Evaluate the benefits of student outcomes
- Evaluate the benefits of the social integration of the students
- Evaluate the benefits to incorporate more students to STEM studies
- Evaluate the benefits of incorporation in the Creative Arts area
- Analyze and evaluate entry barriers to adoption
- Evaluate the impact of the use of VR / AR devices on students from a health point of view
- And to Identify critical KPI's to define a tracking and evaluation value model

In the first contact workshop with the teaching staff, we launched a series of exploratory questions. To do this, we put all the teachers/students in a circle around a virtual axis, where we set a 360º camera for the recording of the session and subsequent evaluation. So we proceeded to brainstorm with the following questions:

- Imagine a class without technology
- What is the value for you of IT in the Classroom?
- How does IT facilitate your daily class?
- How does IT improve education from your point of view?
- Have you done any immersive experience in your class?

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After the Q and A session, we proposed a reflection on how they imagine their classes, the center, and their students in a 10-year future scenario. A special area dedicated to Stem interactive simulators will allow students to approach physics, science or chemistry. Following the common reflection and sharing of different thoughts and ideas, we tried to move forward more quickly and conduct an exercise in disruptive thinking in the classroom:

Think of something Disruptive that made sense in your Class: New Immersive Reality Experiences, Reality based problems and situations (from daily news), 360º Lessons in Streaming Live sharing, WhatsApp Knowledge teams, Makers Communities, Build Learning Resource Centers, How to integrate IT in a Real Context, Managing High Performance Teams, Building Entrepreneurs Teams, Immersive Interactive Digital Arts...Robots?

After this exercise, teachers feel more focused and open for integrating VR technology and now we had to decide when and how. Allowing even to train community members to create their own VR/AR applications to improve their knowledge, activities and allow students to learn through experimentation, thanks to the VR/AR.

At the end of the program, teachers and students will have learned:

- How VR/AR can help schools and institutes teach more in less time
- How VR/AR can accelerate memorization education to higher skills such as critical thinking and problem-solving
- How VR/AR can improve attention in the classroom and awaken a student's curiosity for active learning
- How to use, design, develop, manage, access, store, host and distribute VR/AR applications in a simple way
- Benefits and expected results: At the end of the 3 years program, a series of coordinated actions will be developed jointly among the participating centers and the results of which will be published:
- Identify indicators and metrics to correctly evaluate the results
- Compare the results obtained with those that other institutions are seeing from the VR/AR implemented ecosystems
- Develop and share with the Educational Community Case studies and examples of how other institutions have implemented the VR/AR technology and methodologies
- Develop and share Examples of VR/AR applications for the real world in their future jobs and professions

Lessons learned:

- First impressions really matter. Do not trivialize technology or try to be super@an
- Qualification, training and gap analysis are crucial at previous stages to build up a professional VR/AR educational ecosystem, do not forget it
- You can create many expectations, or you can provide a profound disillusion
- Make it simple, easy and quick to start
- New advanced technologies and in particular "Virtual and AR" reality can help to change the learning paradigm, but it takes time and maturity period
- Do not forget to resolve all infrastructures issues and have everything ready for the show: (Internet broadband width, interconnections, devices ready, headset available, smartphones updated, apps prepared to work, contents ready for class)

There are many ways to implement IT at School, but only one works, when you lead with Excellence, and last but not least, be ready for the day after!!!

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Next steps: We are incorporating new Schools and Educational Centers to increase the number of Referenced Schools and the Educational VR/AR Ecosystem. In October 2018, we are going to sponsorship the “Influencers in Education Seminar”, with more than 300 teachers from educational centers all around Spain. Participating in networking, seminars, training, and workshops in VR/AR. Along 2018/2019 we are going to increase Schools of the Future Program into different countries all around the world and sharing the very first global results.

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7 Conclusions

"The world as we have created it is a process of our thinking. It cannot be changed without changing our thinking". A. Einstein

Throughout this document, we have tried to analyze and describe in sufficient detail, those aspects and fundamentals most relevant for the implementation of advanced technologies in education. From a broad and open perspective, but without forgetting our main reference: the best and most efficient education and training of the students of the future. Keeping in mind, the main role played by the different agents of the educational community and in a very special way the teaching staff. Therefore, we have made a great effort to simplify and provide information, methodologies and reference guides so that teachers can manage in a much more endorsed and professional way in this disruptive world of VR / AR in Education. Being able to become, the real agents of change, from the inside.

Finally, we are going to finish this section with some reflections and conclusions as a summary, in which we will try to synthesize the most relevant aspects of what we covered throughout this document.

VR/AR Technology must be fast and straightforward to be adapted in the school: The First impression really matters, so prevent mistakes using low-cost technology and content for high-end student's expectations.

Use always the best affordable solution and create a positive disruptive environment for your particular VR/AR ecosystem. A full sensorial integration matters for Education; it is a main component and value of VR/AR. Best practices will guide you to success, Bad experiences will drive you to ruin. Make it easy but excellent. If you want to drive your students to excellence, how it is going to happen? Thinking is amazing, making is great, doing is excellence!!!

Learn from your experience, prevent mistakes, think big and global, but apply fast-track methodology to improve your performance again and again. Mistakes have a cost.

Define clear learning objectives for the pilot and get feedback every time you need.
Interact as much as possible with teams and students.

Try to film all your experiences; this can be the best content. Make your students the main actors. Create interaction and activities with students. Measure the results and the impact in the learning process. We will help you to define key performance indicators and evaluate results.

Empowering teachers: Empowering and training teachers with tools and methods to become real entrepreneurs of the educational community and to improve the engagement factor with students as coaches. Teachers must adapt and love the tech to eliminate entry barriers. And the most critical and important issue, provide value and training to the teachers so they are your best ambassadors.Assist teachers and supervisors in planning, developing and implementing the training program for their classroom. Train teachers to identify students needs and the steps to assist them in getting help. Increase teachers and supervisors comfort level with the content and process of the educational program. Expand the repertoire of methods, tools, and actions for delivering the educational program.

7

The diversity of time and space: Through immersive learning, students have the opportunity to study at different times and in different places, encouraging self- training.

Adaptive learning: Different levels of complexity will be adapted for each student, empowering those who have more difficulties for learning.

Experimental Learning: From a simply ‘learning’ topic to an ‘interact and experiment’ mode, the student is able to explore, experience and be involved in something “real”.

Free choice of content and learning paths: Each student can prepare with the tools and topics needed to perform in the industry they choose to study.

The Immersive Experience: Traditional educational materials fail to inspire and engage further learning with most students as it forces them into a form of memory testing rather than retaining knowledge through practice and immersive experience. With an immersive experience the student automatically retains more information by learning through living the experience.

New Evaluation Methods and Processes: In this new context, a new evaluation process has to be defined; according to the new “student learning objectives,” and new performance indicators. That means the exams should change radically. With the help of technology and new methodologies, it is possible to carry out a complete follow-up on the training process, measuring the different indicators according to the evaluation criteria, impact on society and added value provided.