VRinSight

IO2 – Pedagogical aspects of VR learning

KU LEUVEN

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Introduction

The purpose of this document is to provide project partners with an overview of the second intellectual output of the VRinSight project, and to act as a guideline for all partners completing the development of the IO2 Curriculum Modules. These modules are in the first instance, designed for lecturers and teachers of business management study programs in higher education institutes. As a wider audience, this module is aimed at lecturers and teachers of all disciplines, and more broadly aimed at the management of SMEs in Europe. This training program is enriched with a lot of practical VR-cases/exercises/experiences. Therefore, while reading this text, you should use the accompanying VR Classroom and VR Showcase.

When you see this icon of a VR goggle in the left margin, you have the possibility to have a VR experience or to make a practical exercise.

1. VR/AR/MR

Virtual reality (**VR**) is a simulated experience that can be similar to or completely different from the real world (Wikipedia). VR has some interesting characteristics:

1. Due to sensory immersion, ”brain treats it as real”
2. You can turn physics on and off. It is possible, just by selecting the right menu choices, to turn on/off gravity, to allow you to fly at light speed, to walk through walls, to lift heavy weights, etc.
3. You can become a different person (see The Proteus Effect)

Source: VirtualSpeech (VRinSight Showcase)

At this moment, Virtual reality systems in education mostly use both headsets to generate realistic images and sounds and handheld controllers to allow manipulation of virtual objects and to provide force feedback through haptic technology. The headset allows the user to look around the virtual environment. The user can walk around in this virtual environment if the available physical space is large enough and freed from obstacles. As an alternative way to move to another location in the virtual environment, the user can move forward, backward, to the left or to the right with one

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controller and rotate clockwise or counter clockwise with the other controller. To virtually jump to another location, the user can be teleported using his/her handheld controllers. Other sensations like for example smells and tastes are not simulated yet in commercial VR systems.

Applications of virtual reality can include entertainment (e.g. gaming, painting, sports, ...), education (e.g. medical treatments, military operations, machine safety, attitude training, virtual expeditions, traffic courses,...), marketing (virtual tours, virtual product experiences,...) and communication (e.g. meeting people in a virtual room, presenting in front of a virtual audience,...).

Augmented reality (**AR**) is an experience of a real-world environment where the objects that reside in the real-world are enhanced by computer-generated perceptual information, sometimes across multiple sensory modalities (Wikipedia). Information about the environment and its objects is overlaid on the real world. The perceptual information is seamlessly interwoven with the physical world such that it is perceived as an immersive aspect of the real environment.

Applications of augmented reality include entertainment (e.g. games like Pokemon Go,...), education, production (e.g. maintenance support, interactive checklists,...), construction (e.g. architects, AR helmets for construction workers,...), medicine and communication.

Source: https://dealna.com/Article/Post/417/How-Augmented-Reality-Is-Taking-Over-Our-Lives

Mixed reality (**MR**) is the merging of real and virtual worlds to produce new environments and visualizations where physical and virtual objects are integrated into a physical view. Contrary to AR, in MR interaction with the virtual objects is possible.

Applications of mixed reality include product design, surgical operations, communication (be virtually together in the same room,...), repair and maintenance training, entertainment (e.g. immersive video games, immersive sporting events,...)

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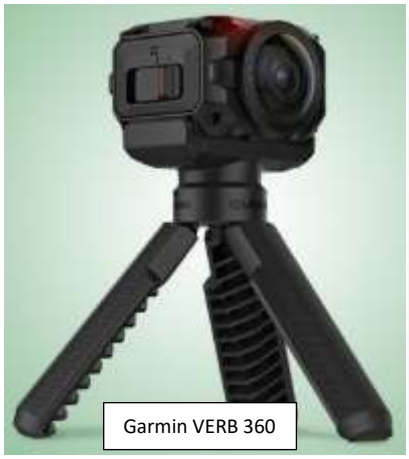
Source: https://www.ia-online.be/artikel/trends-augmented-en-virtual-reality-op-werkvloer/

2. Virtual reality (VR)

You can experience VR in 3 possible ways: as a real but static scene (a 360° photo), as a pre-recorded living scene (a 360° video) or as a computer-generated scene. In each of these 3 versions, different forms of interaction are possible.

360° photo:



Garmin VERB 360

Source: https://www.gettyimages.be/360

Discover 360° photos on the internet (for free) and look around: some examples:

- https://www.gettyimages.be/fotos/360vr?phrase=360VR&sort=best#license
- http://360gigapixels.com/nyc-skyline-photo-panorama/ : 20 Gigapixel panorama's!
- https://vr360.gr/portfolio_categories/home/
- https://vr.marcolodovichi.com/virtual-reality-photo/sanminiatoalmonte/index.html
- https://www.poppr.be/nl/technologie/360-foto-nl/
- https://www.poppr.be/virtualtour/mechelen360/?startscene=0&startactions=lookat(48.12,23.99,108.66,0,0

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If you like, you can create similar stunning applications! When you don't have a professional 360° camera, probably you can take quite reasonable 360° photos with your smartphone. Create a 360° photo using following VRinSight Showcase apps:

- Google expeditions: https://edu.google.com/intl/nl/products/vr-ar/expeditions/
- Thinglink: https://www.thinglink.com/app/

360° video:

Source: https://www.youtube.com/watch?v=8IsB-P8nGSM&list=PL8Tk7Zc_lZHOZWLoj1LznlzPU8K0Uqjm-&index=12

Discover 360° videos on the internet (for free), look around and hold your breath: some examples:

- https://www.revfine.com/360-video/: hotel tours
- https://blog.hootsuite.com/creative-uses-of-360-video-by-brands/: about branding
- https://www.youtube.com/channel/UCzuqhhs6NWbgTzMuM09WKDQ
- https://www.mettle.com/360vr-master-series-free-360-downloads-page/
- https://www.omnivirt.com/360-video-case-study/

Computer generated scene:

Some applications take place in a limited computer-generated three-dimensional environment. Usually there are also three-dimensional objects, furniture, machines, etc. in these rooms. Today, designers increasingly use CAD programs that can draw, save and export a design in 3D. These virtual object can then imported into a virtual space. In education, this possibility can be used to explain an object to an audience that is following the lesson from a physical location anywhere in the world.

Discover computer generated spaces on the internet (free versions); some examples:

- https://altvr.com/
- http://meetinvr.net/
- https://meetingroom.io/
- https://www.dogheadsimulations.com/
- https://www.vspatial.com/app/

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Source: https://www.virtualgamelab.com/research.html

3. Typical VR characteristics

The most unique characteristic of VR is the immersive aspect. Your senses are stimulated (at this moment only your sight, hearing and feeling), you become unaware of the interface and just like in the real world, you can freely move and interact with the environment. These features are used in training conditions to induce and train targeted behavior. Immersion in VR in usually understood as "sensory immersion" that enhances presence (i.e. participants feeling of "being somewhere else"). However, there are different forms of immersion that are important when elaborating the educational benefits of VR, especially motivation to learn within VR (Dede et al., 2017):

- *Sensory Immersion*: Physical information that is acquired via senses. Usually means sensory stimuli that is provided via Head-Mounted Displays (visual information) or, for example, haptics.
- *Actional Immersion*: Ability to do something in a virtual space, interact with virtual objects, etc. Fosters participant's focus in the virtual environment and potential actions that it holds.
- *Symbolic/Narrative Immersion*: Delivered by content of interaction, such as a storyline. E.g. horror movies are frightening because of this form of immersion due to its ability to stimulate viewer's imagination.
- *Social Immersion*: Enhanced by communication in multi-user virtual environments (e.i. social virtual reality, SVR). Participant's feel each other's presence and togetherness via means of verbal and nonverbal communication.
- *Psychological Immersion*: A combination of any forms of presence mentioned above.

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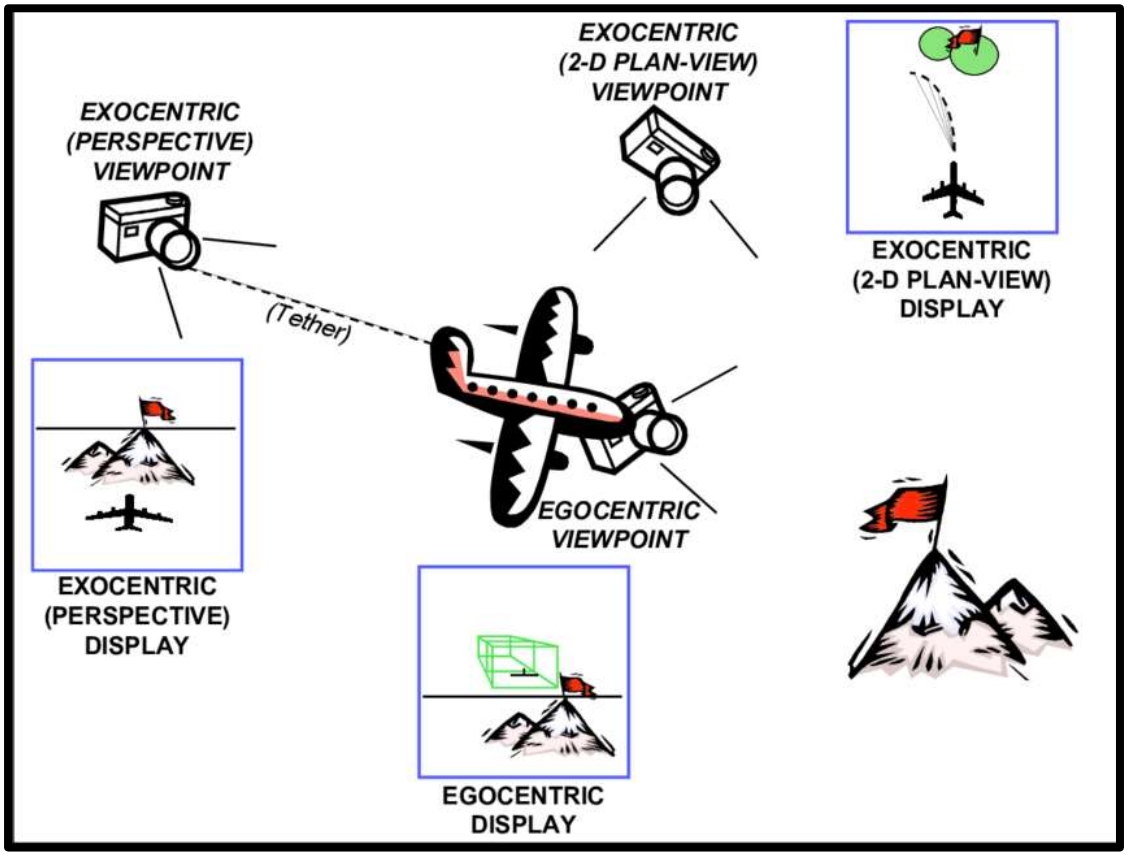
4. Benefits of using VR in education

In general, studies have confirmed that VR can foster learning in at least three ways: by allowing participants to take *multiple perspectives* (Exocentric or Egocentric view), *situated learning* and *transfer*.

Multiple perspectives

Ability to take multiple perspectives helps individuals to understand complex phenomenon by shifting between exocentric and egocentric view (Dede, 2009). Egocentric view provides, for example, embodied learning via avatars in different training scenarios (i.e. just like doing things physically in the real world), where exocentric view enables perspective taking that fosters the learning of more abstract information, such as viewing a landscape in Google Earth.



Source: https://www.researchgate.net/figure/Schematic-representation-of-an-airplane-flying-toward-two-mountains-The-three-cameras_fig4_228367987

Situated learning emphasizes context dependent learning scenarios, in which learners participate in activities and deliver assessments that simulate scenarios from the real world. However, VR is not bound by laws of physics and, therefore, this form of learning can be leveraged in ways that are not physically possible otherwise (e.g., lack of gravity enables flying or lifting of heavy objects). In addition, situated learning can be coupled with real-time guidance or mentoring in a multi-user environment, which makes this form of learning even more efficient. Additionally, the knowledge that is acquired via "learning by doing" is more easily transferred to another situation. Knowledge acquired via the use of VR is less abstract and more concrete.

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Global Teleportation

Source: https://www.pocket-lint.com/ar-vr/reviews/google/142300-google-earth-vr-review-now-with-virtual-reality-street-view

Have you ever visited the Seed Vault in Spitsbergen? Have you ever looked into an active crater? Have you ever enjoyed the aurora borealis in the very Nord of the continent? Have you been walking on the moon? It is so hard or even impossible to get there but VR allows us to visit these places virtually. With the app Google Earth VR, for example, people can traverse the entire planet.

The Time Machine Effect

Source: https://www.vrfocus.com/2019/03/10-key-benefits-of-vr-in-education/

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Students can travel in time and experience the past. If today, you record with a 360° video camera an event like e.g. a lesson, a concert, a conference or a lecture of a guest speaker, students can attend that event afterwards as if they were there. They can virtually look around during the event. Since VR is a relatively new technology, no 360° video content has been recorded in e.g. the Middle Ages. Of course, such a scene can be recorded today while a scenario is played by actors in an authentic or reconstructed set. When the historic site still exists, 360° photo or video content can be used to let students virtually explore the site.

Watch these videos to learn more about the 'Time Ride' museum in Cologne (Germany)

- https://www.youtube.com/watch?v=SgF49cVRpQI
- https://www.youtube.com/watch?v=XjswgkRavb4

Contextualized Learning

Source: https://www.haaretz.com/israel-news/.premium.MAGAZINE-dazzling-visit-to-the-holy-temple-before-its-destruction-1.5452077

VR can also show the context of the learning topic, compared to AR. AR can bring a Greek statue into the classroom and let pop up textual information about the statue. VR, moreover, allows to view the same statue in Ancient Greece. In the picture above, you can visit the Holy temple in Jerusalem and at the same time experience daily life in the vicinity of the temple: how people lived in that time, how they were dressed, what kind of jobs they had, etc.

Multi-Sensory Experiences

Students are able to move within a virtual space and engage with elements like never before. They can play table tennis with a virtual ball, fly a zeppelin with a virtual remote controller, pick up and throw away virtual objects and a lot more amazing things. In all cases, VR delivers an immersive visual environment with accompanying surround sound and haptic feedback through the controllers. Aromas and flavors are not yet included in the multi-sensory experiences. Just look at 'Hold The World' for example (see picture below) where you manipulate fossils as Sir David Attenborough

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helps you understand more about them. Together with him, students can open the drawers, take tools and manipulate the fossils.

Source: https://www.vrfocus.com/2019/03/10-key-benefits-of-vr-in-education/

Extraordinary Abilities

Source: https://www.creativeblog.com/advice/getting-started-with-google-tilt-brush

VR allows us to break the laws of physics: e.g. lift a car, paint with fire, be teleported instantly to another place, look into a machine through its panels,… Maybe more interesting is the fact that a virtual accident, explosion or fall doesn't hurt. That characteristic makes VR an excellent tool to learn the right skills to handle dangerous conditions. The picture above illustrates how you can make 3D virtual art using the app 'Tilt Brush' (from Google).

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Active Autonomy

Source: https://www.vrfocus.com/2019/03/10-key-benefits-of-vr-in-education/

Students can choose where to look and where to go. Each time they are in a physical school trip, the teacher requires them to “stick with the group”. VR, on the other hand, allows them to explore the virtual environment freely. Because of that, they can direct their own flow of information according to their own way of learning.

Empathy Agent

Source: https://www.vrfocus.com/2019/03/10-key-benefits-of-vr-in-education/

VR can be used to foster empathy. Stanford University researchers developed a new VR experience called “Becoming Homeless”. In this VR app, the user lives out the experiences of people who were faced with homelessness after losing their job. In one scenario, the user has to decide which possessions he would sell in order to make his rent payments. In another scenario, the user has to protect his possessions from strangers. As a result of a study, users who underwent VR experience were more likely to feel lasting sympathy for the homeless than those who got to know the situation of homelessness through other media, such as by reading an article.

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Watch the video about 'Becoming Homeless':

- https://www.youtube.com/watch?v=L9UZchvKzys

Virtual Rehearsal

Source: https://www.vrfocus.com/2019/03/10-key-benefits-of-vr-in-education/

Today, some VR apps exist that allow to practice and hone skills without fear of failure. This way of improving your skills is incredibly powerful. One of those apps, VirtualSpeech, is very useful to practice public speaking. A Frog Dissection app allows to develop skills in the Biology classroom, potentially saving a lot of money in the process! The app in the above picture allows users to select the right fire extinguisher for each fire and to practice extinguishing fires.

Focused Immersion

Since VR is an experience played inside a headset, the user is less prone to distractions in his physical surroundings. For some students this type of learning may be very useful because they are prone to distraction, which leads to a loss of focus and ultimately a loss of learning efficiency. The immersive nature of VR means that students are inundated with learning topics, so this is a key factor in the retention of information. In the picture below, an immersive VR app distracts patients from their painful condition or from a painful medical treatment.

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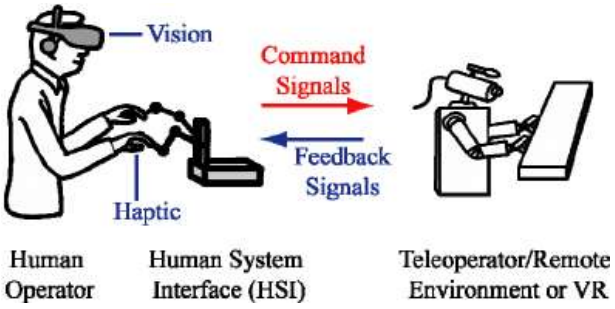
Source: https://www.vrfocus.com/2019/03/10-key-benefits-of-vr-in-education/

Remote Presence



Source: https://avatour.co/2019/10/08/what-is-remote-presence/

Source: https://www.researchgate.net/figure/Multimodal-presence-system-A-virtual-or-remote-environment-is-mediated-to-a-human_fig1_228954511

Remote presence is quite simply the immersive experience of a real place, including real-time remote interaction with the people there. It's an important new tool for improving business effectiveness. It reduces the need for travel, saving time, money, and the environment. It's also the best substitute for when real presence is simply impossible. Students using VR can connect with other students as well as attend lectures and lessons delivered by educators across the globe using multi-user social VR platforms like Engage and AltSpace. In the near future, these platforms will become thriving hubs for educational content. In Belgium, children with a long-term illness can use the BedNet app to have a virtual presence in their classroom from their hospital bed and to communicate in real time with the teacher and the group. In the above picture on the right, a human operator like e.g. a surgeon, a maintenance operator, a de-miner,… uses a human system interface to command a robot at remote location. In return, the operator gets visual, auditory and haptic feedback.

Transfer

Since 1948 Bloom's Taxonomy of Educational Objectives has been the standard for the classification of educational goals for learning outcomes and engagement. Traditional teaching and learning is accomplished in the lower levels of the taxonomy and focus on educational transfer. Often, the goal

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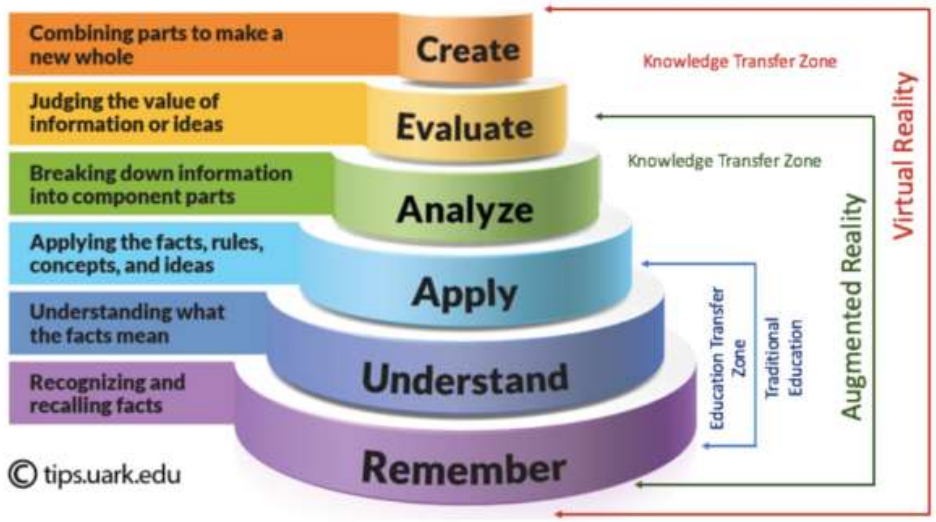
of educational transfer is to remember and recall the context of a subject matter, resulting in a diploma or a certificate.

The higher levels of Bloom's taxonomy focus on knowledge transfer. Knowledge transfer requires a person to analyze, synthesize, and even create things based on the knowledge that has been transferred to them. VR allows to learn knowledge, skills and attitudes in many different contexts. This knowledge, acquired via 'learning by doing', is more easily transferred to another context. As a result, students will be able to more quickly analyze a situation, evaluate an implementation and come up with an appropriate new solution.



Source: https://www.talentquest.com/full-bloom-with-mixed-reality/

5. Benefits of VR for policy makers

Source: https://statements.eahp.eu/stakeholders-information-stakeholders-policy-makers/what-do-statements-mean-policy-makers

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For policy makers, creating jobs and increasing productivity in both industry and services are at the top of their agenda. The key to attain this goal is the development of competencies of all managers and employees. However, the current workforce in most countries are not ready to meet the job market 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 behavioral. (World Bank. Education Overview March 2017). Well, with VR technology, schools will have a powerful tool to train certain behaviors and to attain a significantly higher retention rate than traditional teaching. Now, it's up to our policy makers to actively promote and encourage the use of VR in education.

6. Pitfalls of using VR in education

Source: Els Verweire in EOS, 'Virtual reality in onderwijs'

1. Robin De Lange from Virtual Reality Learning Lab in the Netherlands: "We learned from experiments that young students are very enthusiast when their teacher proposes to use the VR headsets in the classroom. Afterwards, these students are convinced that they learned more compared with the traditional way of teaching. But this is not always true. VR is not just an alternative way to teach. Teachers have to consider in advance what they want to obtain with the use of VR. VR is only relevant in education if you use it to obtain a learning output you cannot accomplish in another way."
2. Try to limit the duration of a VR session. Intensive use of a VR headset results in following complaints:
    a. a VR head mounted display isolates students from the physical environment which leads to disorientation,
    b. VR apps may contain a plethora of stimuli, disturbing for hypersensitive people as for example autistic students; for other students, the fact that VR allows to look around 360°, makes it such an overwhelming experience that they miss the aspects to which they should pay attention.
    c. When virtual movements don't match movements in the physical world, like in roller coaster VR videos, students may become dizzy.

Source: https://vrgames.io/virtual-reality-sickness/

3. Some VR app developers have not enough feeling with education. Their apps are beautiful but are not adapted to the foreknowledge or vocabulary of the students for whom they are intended. If the VR app assumes a lot of foreknowledge and when it contains high-flown vocabulary, students get knocked off. On the other hand, when an app is developed for a lower level in education, students will get bored.

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7. Barriers to VR adoption

Source: https://www.virtualiteach.com/single-post/2019/03/31/5-Key-Barriers-to-VR-Adoption

It's difficult for educators, who know the educational potential of VR, to convince their management to start integrating VR in their schools or institutions. School leaders vetoing VR project proposals take decisions based on misconceptions, lack of understanding or fear of the unknown. Or they don't understand what virtual reality actually is or they have experienced 360° images or videos and have the misconception that VR is limited to that kind of applications. What are the barriers they perceive?

1. A lack of understanding VR

   To help them understand the power of VR, let them try it for themselves! Let them fly with Google Earth VR in no time from one touristic location to another, let them make 3D-paintings and walk through it with Tilt Brush or let them experience walking the plank from the top level of a skyscraper with the famous app 'The Plank VR'. They will feel that these applications really affect them and they will conclude that VR has a huge potential in education.

Source: https://www.pinterest.com/pin/564427765791411837/

2. Cost and ROI:

   Schools have tight budgets and these budgets have many pulls. That's why the school board considers it as a risk to invest in a new kind of technology. But, as a start, the investment can be limited. It is not necessary in a classroom, to have one headset for every student. There are many ways to integrate VR in a lesson. VR and spatial computing as a whole is the future of how we will interact with all digital content across every industry. The fact that VR

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represents a complete different way to interact with digital content, makes this barrier even harder to overcome. When the iPad was introduced, it was broadly familiar with a laptop computer. The iPad was in fact a small computer with touch-screen functionality while VR totally changes the hardware interface as well as the very nature of the content it offers. 3D interface provided by VR will soon substitute or even replace conventional 2D screens. Schools have to start preparing our youth for this shift to immersive technologies now. An investment in VR makes an educational institution ready for the future. But what about the ROI? Let us be critical: Is ROI the right criterion? Ultimately, we are talking about empowering students to be prepared for their jobs in the future. Achieving that goal is the highest ROI.

Source: https://www.virtualiteach.com/single-post/2019/03/31/5-Key-Barriers-to-VR-Adoption

3. Rate of change

Source: http://www.arvrmagazine.com/niantics-strategy-in-augmented-reality-pikachus-are-just-the-beginning/

Martec's Law states that technology changes exponentially while organizations change much more slowly. That means that, even when an educational institution want to be an early

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adopter of new technologies, their decision process and implementation process are slower than the pace of technological evolution!

Schools have fear of "jumping too soon". Technology is constantly evolving and there will always be a newer/ bigger/ smaller/ faster/ quieter/ more powerful version coming next. If schools wait to invest in new technologies because there is something very promising in the pipeline, they will never adopt a new technology and, in the end, their students will lack the necessary job skills and competences to become an efficient and successful professional.

We have to be aware that most of our students are generally more technology-savvy than school staff since they are growing up with technology every day. They are used to services with the adjectives: 24/7, wireless, animated, interactive, visual, instant, intuitive,… To this list, VR can add a new and thrilling adjective: immersive!

4. Health and safety

Is VR safe for our children? Among hundreds of other concerns, parents also have concerns about their children using VR. Top concerns are:

- Sexual content/porn/violent content: this concern is not related to VR only. When children use a smartphone, a tablet or a computer linked with the internet, they already have access to this kind of content.

Source: https://tablet-news.com/global-tablet-pc-and-smartphone-sales-expected-to-stabilize-in-2019/

- Too much time with VR: A lot of children and teens have the same problem with for example watching television or playing games with on-line opponents or using a gam e console. The solution is parenting: set limits to this kind of entertainment, be consistent and talk to your child about their impressions. The advice from professionals is: 2-3 minute sessions for children <6 years old (and without using the head strap so that they don't feel trapped in any way) and 10-15 minute sessions for young people <13 years old.

Source: https://www.vingle.net/posts/2684783

- Social isolation: once you put on a headset, it is not possible anymore to have eye contact with other people in your physical environment, but maybe you are meeting new people in a virtual space like AltSpaceVR where you can talk to each other live but where you can see the participants to the meeting (as avatars). Social isolation didn't arise with VR.

Source: https://newatlas.com/seeing-i-project-mark-farid/34921/

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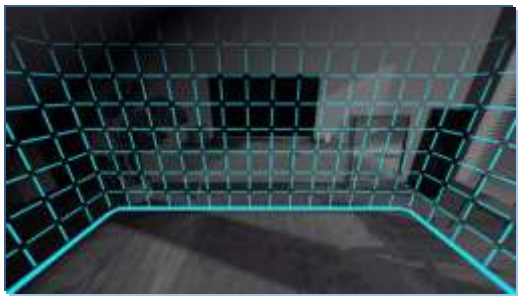
Young people excessively using their smartphone at home are also ‘absent’ for their family. Again, the solution is parenting.

- Health and safety concerns:

1. Since the user cannot see the physical environment, there is a risk to bump into something. To avoid this, modern VR systems oblige the user to mark a chaperone. This is the digital cage of boundary lines that the user can draw with his controllers to mark a cleared physical area in the room where he is using the system. When the application does not trigger the user to move around or to make gestures with his controllers, the user can just sit down for safety.



Source: https://www.androidcentral.com/how-many-vr-rooms-can-you-save-oculus-quest

2. Dizziness through the use of VR is generated by those apps in which the user moves virtually fast without feeling the expected G-forces. The equilibrium system feels fooled by for example roller coaster apps or apps like Google Earth VR. In professional flight simulators or F1 race simulators, G-forces are more or less generated by complex hydraulic actuators and so the immersive experience is even higher.

3. There is no evidence that the use of a VR head mounted display leads to eyestrain, especially if the duration of the VR session is moderated carefully. Of course, just like when you read a book, if you don’t take a pause from time to time, you invoke eyestrain.

Source: https://www.vrlife.news/vr-may-cause-long-term-negative-effects/safety/

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5. Benefits to learning

Source: https://www.vortez.net/news_story/tobii_pro_expands_eye_tracking_research_into_vr.html

Some hesitating decision makers say: “There still hasn’t been enough research into the benefits of learning with VR”. OK, although research into the benefits of learning through VR is still quite in the start-up phase, the results observed by research institutes from all over the world are pointing to the same direction: VR raises engagement, it fosters concentration and ultimately it can increase the retention of information. It is a tool for leading students into a focused state of concentration where deeper learning is possible.

- VR fostered positive emotions in students and improved learning outcomes. (Warwick University)
- VR was the preferred learning medium by a majority of students tested. (Cornell University)
- VR improves students’ concentration by 6x (Saga University)

8. Social VR

Definition:

Social virtual reality (SVR) allows people to meet other people at a virtual location using a VR headset and a social VR app. It is a tool that allows friends sitting in different parts of the world to feel like they are spending time in the same room. It has a potential to dramatically change how

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individuals interact online and is one of the killer apps for VR. Participants customise their own avatars and interact as if they are actually in the simulated environment.

Social VR tools and their features:

In order to meet each other, all visitors of a virtual space have to create an avatar first. During the virtual meeting, they can manipulate virtual objects while talking to each other and making gestures using their handheld controls. Social VR tools include:

1. Virtual space: This is a virtual location (meeting room, loft, garden, parc, sports field,…), accessible by several people (public or with limited access). Handheld controls allow to navigate all around the location as if you were a ghost. Spatial sound gives an even more immersive experience.

2. Avatars: An avatar in a virtual space is a personalised three-dimensional graphical representation of a computer user or his alter ego. Although people can extensively customise their avatar, according to many studies, the most important aspect of an avatar is it's realistic behaviour.

3. Virtual objects: more and more developers use 3D drawing software to design new products and parts. When these designs can be saved as a VR compatible format, the objects can easily be brought into a virtual space. Additionally, some kinds of manipulation are allowed in order to let the user do something useful with the objects.

4. Verbal communication: Avatars can speak with each other. You then hear the real voice of the person speaking. And when you look at the avatar speaking, you see his mouth moving. Alternatively, in most social VR apps, also a chat functionality is available for text-based interaction.

5. Non-verbal communication: It's impossible not to communicate. Even when we prefer not to say anything, we still communicate non-verbally. This is also true in VR. Our avatar copies our head, lips (lip sync), eyes (blinking), hands and in the near future also our finger movements. In a further future, the face of our avatar will be a scanned version of our own face. At this moment, non-verbal communication consists of

- emoticons you can show, just to let people know how you feel,
- head movements like nodding yes or no, looking down, looking at the speaker,…

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- posture since you can choose a tall or a little avatar. You can choose his clothes in different colours
- tone of your voice since they hear you speaking,
- gaze tracking: this feature is used in the app Virtual Speech. This app checks whether or not you are looking at the whole audience during your speech or presentation.

The Proteus effect

As soon as people create and use an avatar to meet other people in a virtual space, the characteristics of the chosen avatar may have psychological and behavioral implications, changing the user's attitudes in real life. Studies revealed that:

- Research study result 1: Participants assigned taller avatars behaved more confidently in a negotiation task than participants assigned shorter avatars (The proteus effect: The effect of transformed self-representation on behavior, Yee and Bailenson, 2007)

Source: http://www.vistanimations.com/imvuCatalog/AssassinMale/Tall.html

- Research study result 2: This effect persisted in subsequent face-to-face setting as well (The Proteus Effect: Implications of Transformed Digital Self-Representation on Online and Offline Behavior, Yee and Bailenson, 2009)
- Research study result 3: "The experimenters found that participants in attractive avatars walked closer and disclosed more personal information to their communication partner than participants in unattractive avatars. (The Proteus Effect: Implications of Transformed Digital Self-Representation on Online and Offline Behavior, Yee and Bailenson, 2009)

Source: https://meagantheyoung.tumblr.com/post/164575422090/avatar-oc-week-avatar-oc-week-day-4-early

- Research study result 4: Also these results (boost in self-confidence) lasted after the experiment in real world settings as well. It has been measured by the use of a dating app. (The Proteus Effect: Implications of Transformed Digital Self-Representation on Online and Offline Behavior, Yee and Bailenson, 2009)

Source: https://lindabonnarlifecoach.com/just-three-things/just-three-ways-to-increase-your-self-confidence/

- Research study result 5: participants who saw their avatars exercise and be rewarded for exercising were more likely to increase their physical activity in a real-world setting.
- Research study result 6: A new social experiment on Facebook reveals introverts open up more in VR (source: https://www.businessinsider.com/facebook-social-experiment-reveals-introverts-open-up-more-in-vr-2017-1?r=US&IR=T&IR=T)

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Social psychology

It is widely acknowledged that stronger social ties improve the collaboration performance in organizations. Well, SVR enables and fosters tie strengthening. We define tie strengthening as a socially derived accumulation of tie strength components. Granovetter (1973) argued that "the strength of a tie is a (probably linear) combination of the amount of time, the emotional intensity, the intimacy (mutual confiding), and the reciprocal services which characterize the tie."

The synthesis of findings from 3 studies reveals 5 well-established phenomenon in tie strengthening: *trust*, *reciprocity*, *informality*, *emotional intensity/support*, and *interacting with presence*.

Trust: mutual and interpersonal, willingness of being vulnerable, willingness to rely on others

Reciprocity: reciprocal interaction (providing respect in exchange for advice), reciprocal services (doing favors for others)

Informality: voluntary time investment in the tie, the desire for companionship, multiple social contexts, when participants interact with each other as unique individuals, rather than as occupants of social positions. Leveraging informality creates many benefits in organizations: enhanced innovation capabilities, informal knowledge sharing

Emotional intensity/support: a cognitive appraisal of perceived physiological arousal (NL: een cognitieve beoordeling van de waargenomen fysiologische opwinding). If ties are strong, it is more likely for individuals to be exposed to strong emotions, mainly due to the interconnected nature of the relationship. However, expressing strong emotions in and of itself (even positive ones) does not necessarily create a strong tie.

Interacting with presence: This is the sense of "being there" in the virtual space. It is about intimacy, closeness, how we behave, what we pay attention to and how we understand and remember. Participants tend to, at least partly, forget the role of technology in the process.

Synchronous and asynchronous communication

SVR enables many forms of synchronous or asynchronous interactions:

With synchronous communication users are connected at the same time, they have a conversation in real-time while the number of participants is rather limited. Some examples:

- Text chat, instant messaging
- Voice chat
- Virtual worlds (e.g. Second Life)
- Videoconferencing
- Shared window function

With asynchronous communication on the other hand, users are not online at the same time, so conversation is 'Delayed' conversation but the number of participants may be unlimited. Some examples:

- Discussion groups & document sharing
- Time schedule & announcement boards
- Social networking (e.g. Facebook)

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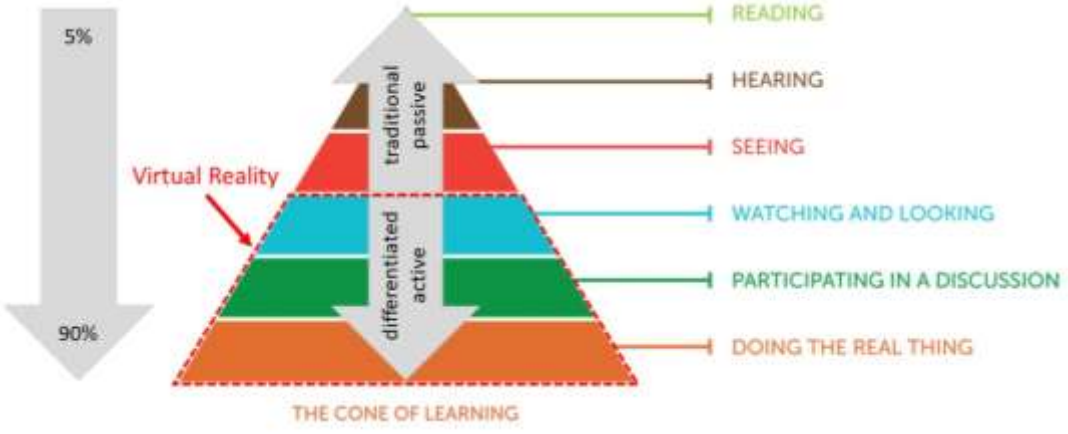
- Q&A with FAQ feature
- Online polling
- Email

9. Using VR in education

Advice for teachers

- If you, as a teacher, have to recommend a VR set-up to your school board, first consider the most appropriate platform. If the application is developed for a head mounted display connected to a computer, the virtual experience can be very powerful and fast but the physical wire connection with the computer will limit the student's elbow-room and these configurations are significantly more expensive. If, on the other hand, your application is developed for mobile systems based on iOS/Android/Windows Mobile/… the user has the freedom to move around in the physical room (as far as it is cleared). Mobile head mounted displays are less expensive, especially the ones in which you have to put your smartphone. These VR systems are particularly useful for educational institutions with small budgets.
- Take into account age recommendation ratings for VR equipment like headsets to ensure maximum comfort and safety for your students.
- Look for the good stuff. Seek for unique educational experiences that enrich the knowledge and speed up the comprehension of your target user group.
- Check reviews to find out if the application content is OK for your students.
- Optimise safety: limit the duration of sessions to avoid dizziness, move furniture out of the way and make your student stay seated to prevent him/her from colliding with objects in the physical environment
- Have someone present who will give feedback about perceived emotions.
- Monitor feelings like dizziness, anxiety or confusion and try to observe the non-verbal communication immediately after the VR session. They are signs to take a break.
- Talk about the VR experience. Ask the student to share his/her experiences with you.

Learning methods with high retention rate



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Go to the VRinSight Showcase and discover the app ClassVR. Make a SWOT analysis of this app for one of your classes.

The Learning Pyramid is a representation of the average retention rate for a range of different learning methods. Traditional learning methods, like ex-cathedra teaching, reading a text, watching a video and looking at a demonstration, have the lowest retention rate. Students stay very passive during these learning methods and their learning is based only on what they hear and see. The more a learning method is situated towards the bottom of the pyramid, the more the students are actively participating during learning. For those learning methods, like discussion groups, practice by doing and teaching each other, learning is based on a higher extent of reflection and a deeper cognitive processing. Teaching each other has the highest retention rate. In order to be able to explain something to another one must know the subject very well. The better the subject is known and understood, the better it can be explained.

Physical multiplayer simulation games are popular in business management education (e.g. business games) and production management (e.g. lean games). In these games, participants have a double role: on one hand, they are workers in a process and on the other hand, they have to find and to discuss about improvement actions. These improvement actions can be implemented in the game and in a next round they can measure the results of their decisions. As with VR, wrong decisions don't lead to any harm. Instead, they are an additional and unforgettable experience.

Learning with VR belongs to the activating working methods. Users have to use their handheld controls to move, to communicate (non-verbally), to manipulate objects and to select menu options. The fact that a head mounted display prevents the user from being distracted, even further increases the retention rate of VR.

Assignments

Assignment 1:

Discover one of the VR applications from the VRinSight Showcase and discuss with a colleague its use in education.

- What can students learn from this application?
- How would you integrate it into a lesson?
- What should be done before?
- How would you coach your students using this application?

Assignment 2:

Organize a VR meeting with friends/colleagues using AltSpaceVR. On the agenda: e.g. the organization of a common activity.

- Afterwards, compare benefits and drawbacks of a VR meeting compared to a Skype meeting and compared to a physical meeting.

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- For what kind of meetings and activities do you recommend AltSpaceVR? Why?
- In what way should developers improve AltSpaceVR to make it more capable for educational use?
- Have you experienced the Proteus effect?

Assignment 3:

Use a VR app to explain a virtual object to an audience.

- What are benefits and drawbacks of this kind of teaching?
- What kind of useful applications for this way of teaching/training have you in mind?
- Compare this way of teaching with alternatives like using the physical object in a physical classroom or laboratory, internship,… and others.
- How did your students react? Was it worth the effort? Do they now have a better understanding of the topic?

Assignment 4:

Use Google Expeditions to illustrate a course topic.

- Reflect about the added value and the inconveniences.
- Compare Google Expeditions with real physical expeditions.
- Brainstorm about possible applications of Google Expeditions.

Assignment 5:

Use a 360 photo camera and the free version of the VRinSight Showcase app Thinglink to let new students discover your classroom/lab/campus.

- Make a work plan to fulfill this assignment with your team.
- Include hotspots to show text, pictures, videos as well as web links.
- Show the result to a younger student and ask him/her for some feedback.

Assignment 6:

Go to chapter 4 “Benefits of using VR in education”. For each of the mentioned benefits,

- Find another example than the example mentioned in this presentation or mentioned by the teacher.
- Why is your example an illustration of that benefit?

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