Human Factor Guideline

for the Educational Application of Virtual and Mixed Reality Technologies

LASI-Korea 2017

(August 31, 2017)

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Recent involvement in virtual reality by technology giants

Company	Date	Details
Qualcomm	Jan-12	Raised seed funding for the mobile augmented reality startup Blippar
Google	Apr-12	Introduced augmented reality glasses, Google Glass, to the public
Sony	Mar-14	Sony announces Project Morpheus, later renamed PlayStation VR
HP	Mar-14	Launched Aurasma 3.0, an augmented reality platform that it acquired through Autonomy
Facebook	Mar-14	Acquired Oculus, a virtual reality startup, for $2bn
Samsung	Sep-14	Revealed its own head-mounted display, Samsung Gear VR, partnering with Oculus
Google	Oct-14	Invested $542mn in the startup Magic Leap
Intel	Apr-15	Invested in Series A funding for the virtual reality startup WorldViz
Apple	May-15	Reportedly acquired Metaio, an augmented reality software maker
Disney	Sep-15	Led a $65mn funding round in Jaunt, a VR content startup
Microsoft	Oct-15	Acquired Havok, a 3D physics engine used for videogames
Comcast & Time Warner	Nov-15	Participated in a $30.5mn funding round for NextVR, which captures live events in VR
Apple	Nov-15	Acquired Faceshift, a facial recognition capture and animation company
Fox	Jan-16	Acquired minority stake in Osterhout Design Group, a VR/AR HMD maker

※ Source : Goldman Sachs(2016). Profiles in Innovation-Virtual & Augmented Reality. The Goldman Sachs Group, Inc.

Facebook’s 10-year master plan

※ Source

- Business insider(2016). Facebook has created a new 'Social VR' team to explore how we'll communicate in virtual reality. http://www.businessinsider.com/facebook-social-vr-team-2016-2)
- Business insider(2017). Mark Zuckerberg just signed the death warrant for the smartphone (http://www.businessinsider.com/facebook-f8-mark-zuckerberg-on-augmented-reality-2017-4)

Microsoft’s Mixed Reality Project

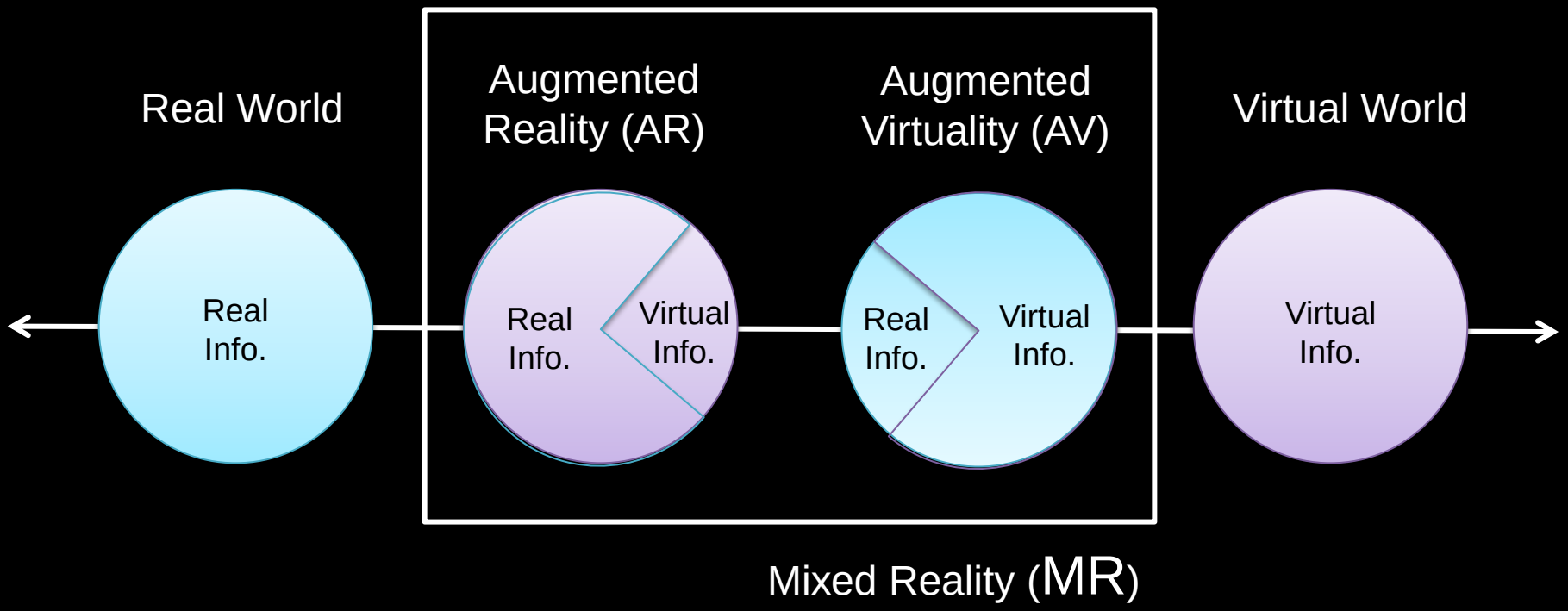
※ Source

- Microsoft HoloLens - Microsoft virtual reality glasses(https://www.youtube.com/watch?v=u4o0zsJ-S44)
- IT동아(2017).[MS 빌드 2017] 가상현실의 대중화 꿈꾸는 MS, 비결은 조저가 (http://it.donga.com/26382/)

Google Expeditions

※ Source : https://edu.google.com/expeditions/#explore

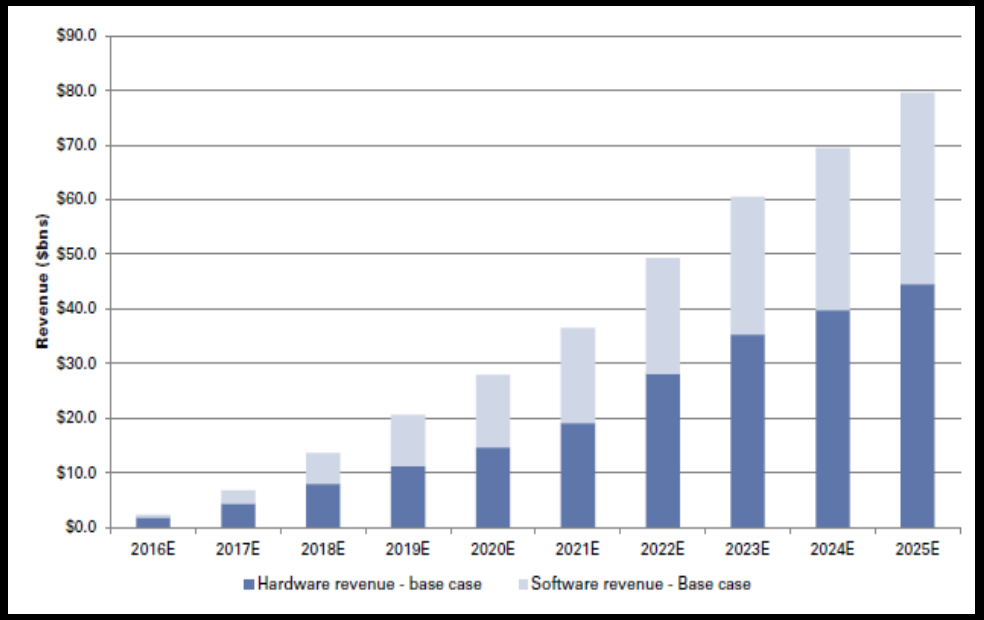
What are the AR, AV, MR?

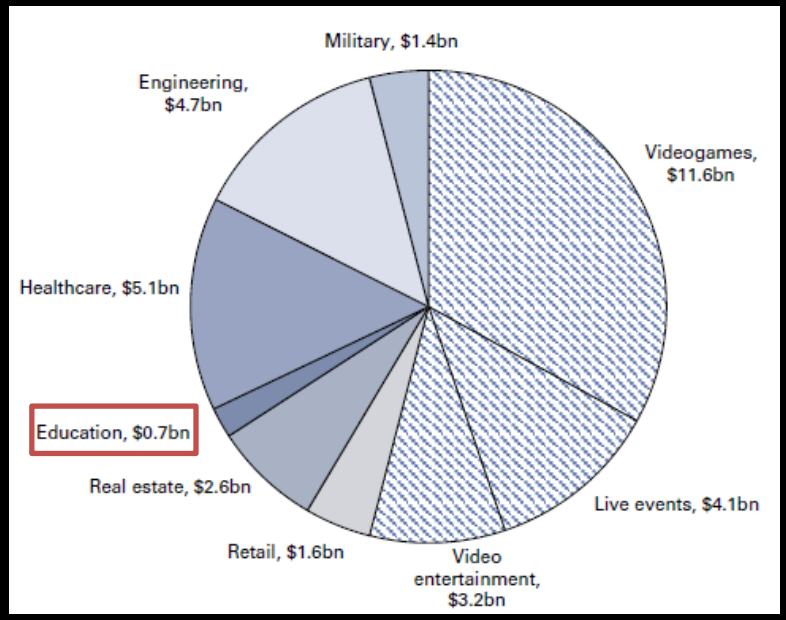


※ Source

- 정승혁(2016). ICT 정보통신기술 핵심 100선. 도서출판 WARMING
- Milgram,P.,&Keshino,F.(1994).AtaxonomyofmixedrealityvisualdisplayIEICE.TransactionsonInformationandSystems,E77-D,12,1321-1329.

2025 base case VR/AR Software assumption by use case

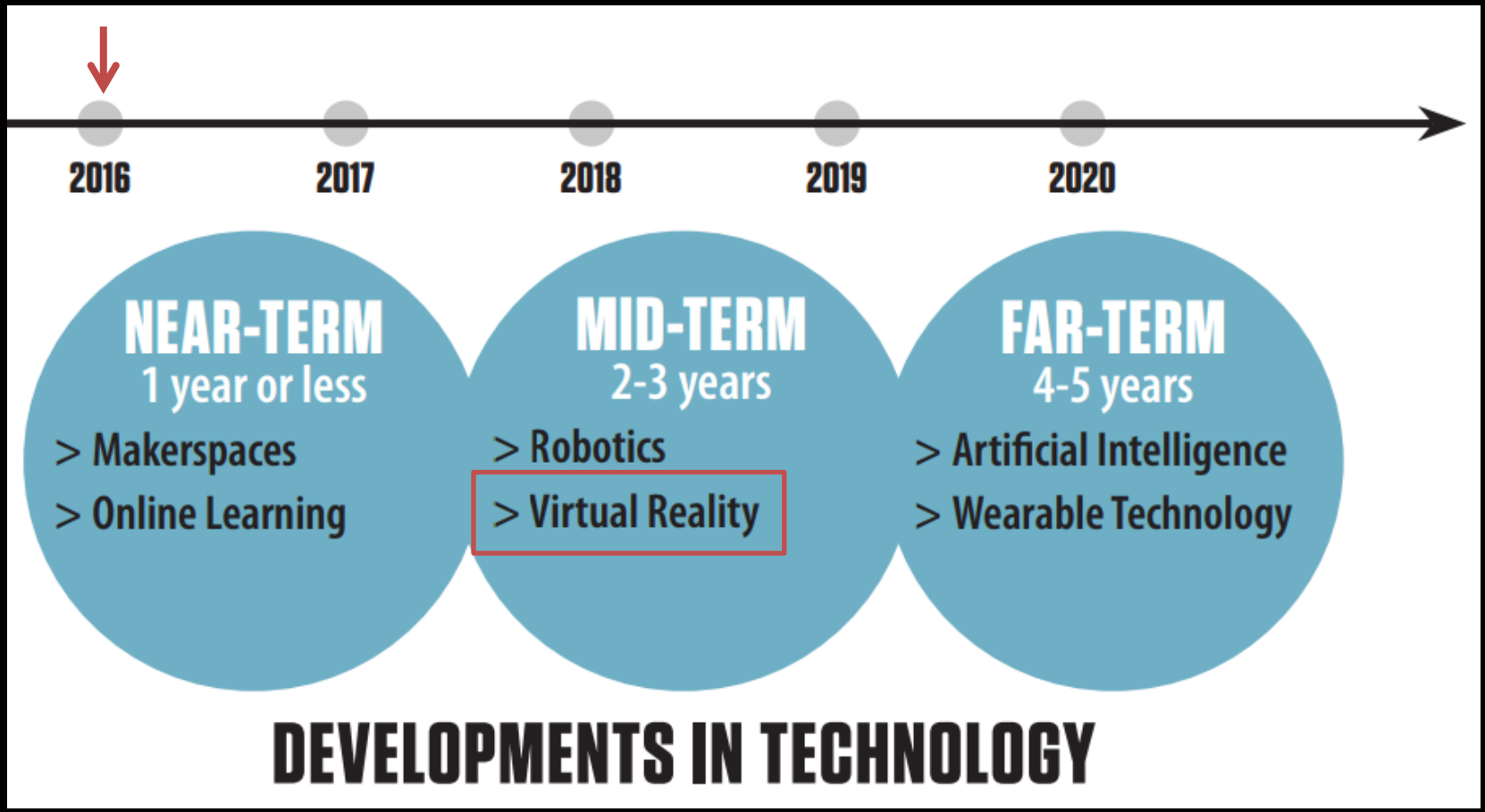




	Current market size	Datapoints on the population that could use VR/AR	2020 Base case assumptions		2025 Base case assumptions	
	The market VR/AR is playing into	*To gauge the magnitude, the population that VR/AR could sell into*	**Users**	**Software revenue**	**Users**	**Software revenue**
Education	Education software market: $5bn for K-12, $7bn for higher education	~200mn primary and secondary students in developed markets In US, ~50mn K-12 and ~20mn college students	7mn	$0.3bn	15mn	$0.7bn

※ Source : Goldman Sachs(2016). Profiles in Innovation-Virtual & Augmented Reality. The Goldman Sachs Group, Inc.

Important Developments in Educational Technology for K-12 Education @2016



※ Source : The NMc/CoSN Horizon Report : 2016 K-12 Edition (http://cdn.nmc.org/media/2016-nmc-cosn-horizon-report-k12-EN.pdf)

From survey..

62%

of 606
Germany teachers

83%

of 1,011
U.S. K-12 teachers

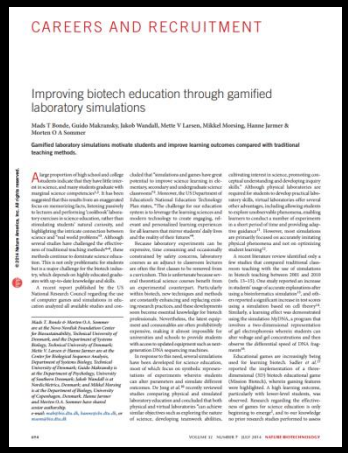
say that **virtual reality might help improve learning outcomes**

※ Source

- Samsung(2016). Is virtual reality ready for the classroom? http://www.samsung.com/us/system/b2b/resource/2016/06/29/INFOGRAPHIC_VR_in_EDU_Survey_JUN16AP_1.pdf?redir=VIRTUAL%20REALITY.
- 삼성 뉴스룸(2017). VR 활용 학교 교육, 독일 교사들의 생각은? https://news.samsung.com/kr/%EA%B0%80%EC%83%81%ED%98%84%EC%8B%A4-%ED%99%9C%EC%9A%A9%ED%95%9C-%ED%95%99%EA%B5%90-%EC%88%98%EC%97%85-%EA%B5%90%EC%82%AC%EB%93%A4%EC%9D%98-%EC%83%9D%EA%B0%81%EC%9D%80

The results demonstrate that

Using the laboratory simulation led to significantly improved learning outcomes **(76% higher score)** compared with traditional teaching ($t(89) = -4.37$, $P < 0.0005$). Effects of combining the simulation with traditional teaching were assessed with the post-test, and the measured learning outcomes were greater than any one of the methods alone ($t(90) = -7.49$, $P < 0.0005$; see Fig. 3b).


CAREERS AND RECRUITMENT

Improving biotech education through gamified laboratory simulations

Mads T Bonde, Guido Makransky, Jakob Wandall, Mette V Larsen, Mikkel Morsing, Hanne Jarmer & Morten O A Sommer

Gamified laboratory simulations motivate students and improve learning outcomes compared with traditional teaching methods.

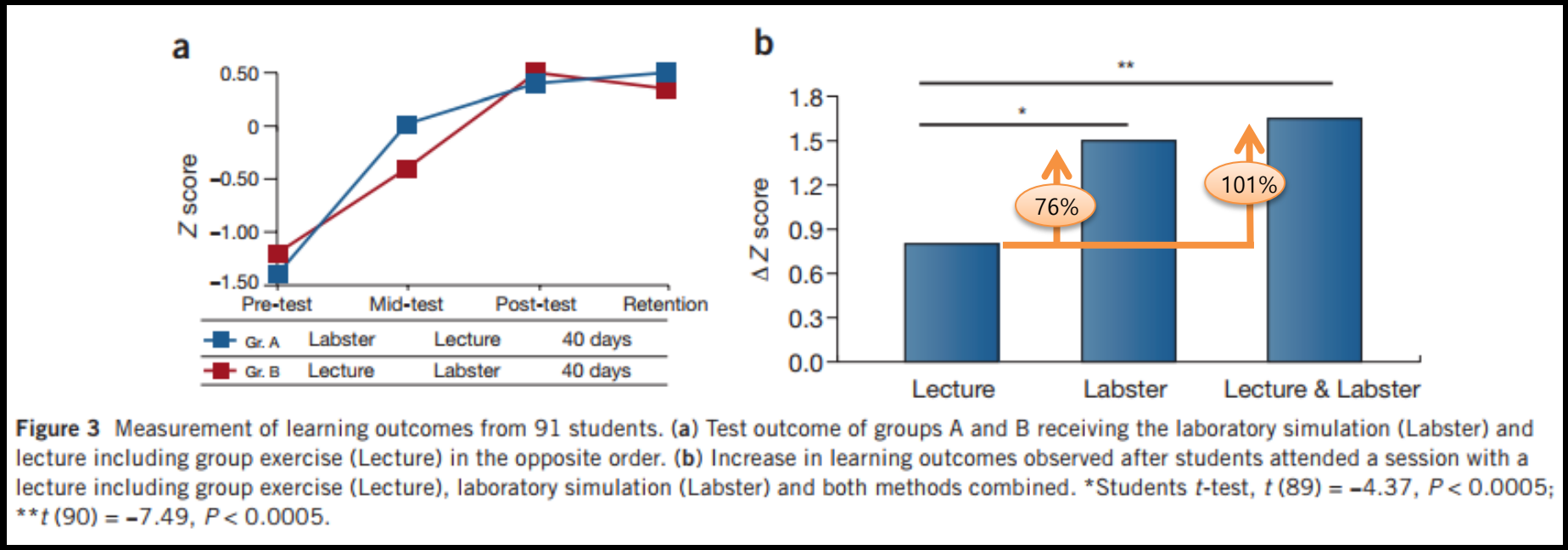
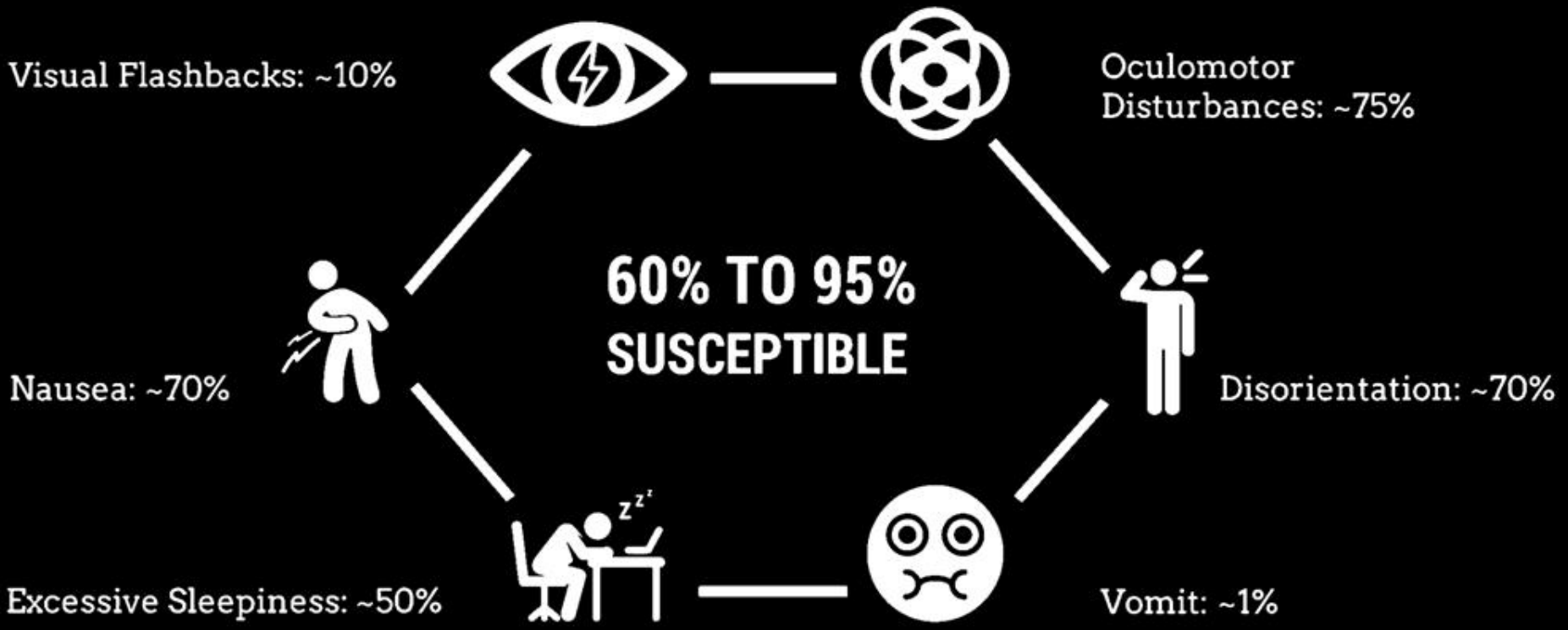


Figure 3 Measurement of learning outcomes from 91 students. (**a**) Test outcome of groups A and B receiving the laboratory simulation (Labster) and lecture including group exercise (Lecture) in the opposite order. (**b**) Increase in learning outcomes observed after students attended a session with a lecture including group exercise (Lecture), laboratory simulation (Labster) and both methods combined. *Students *t*-test, $t(89) = -4.37$, $P < 0.0005$; **$t(90) = -7.49$, $P < 0.0005$.

※ Source : Mads T Bonde, Guido Makransky, Jakob Wandall, Mette V Larsen, Mikkel Morsing, Hanne Jarmer & Morten O A Sommer(2014). Improving biotech education through gamified laboratory simulations. Nature Biotechnology 32, 694–697

But…



※ Source : http://www.designinteractive.net/blog-cybersickness.html

Also...

Age	Grade	Mattel View-Master® VR	Sony Play Station VR	Samsung GEAR VR	Oculus Rift	3D TV	Eletrical device
-						Under adult guidance (under 10)	
5							
6	K-1	available (above 7)	restricted (under 12)	restricted (under 13)	available (above 13)		2 hours limit a day (6~18)
7	K-2						
8	K-3						
9	K-4						
10	K-5						
11	K-6						
12	K-7						
13	K-8						
14	K-9						
15	K-10						
16	K-11						
17	K-12						
18							
+							

7 for users

9 for contents creators

Human Factor Guidelines

for the Educational Application of Virtual and Mixed Reality Technologies

7 for users

1. Check the status of users
2. Review the H/W and S/W recommendation for use
3. Use only in a safe environment
4. Take frequent breaks during use
5. Be careful about burns caused by heat of device
6. Call attention to distinguish between reality and virtual / mixed reality
7. Monitor children (age 13 and older) closely during and after use

9 for contents creators

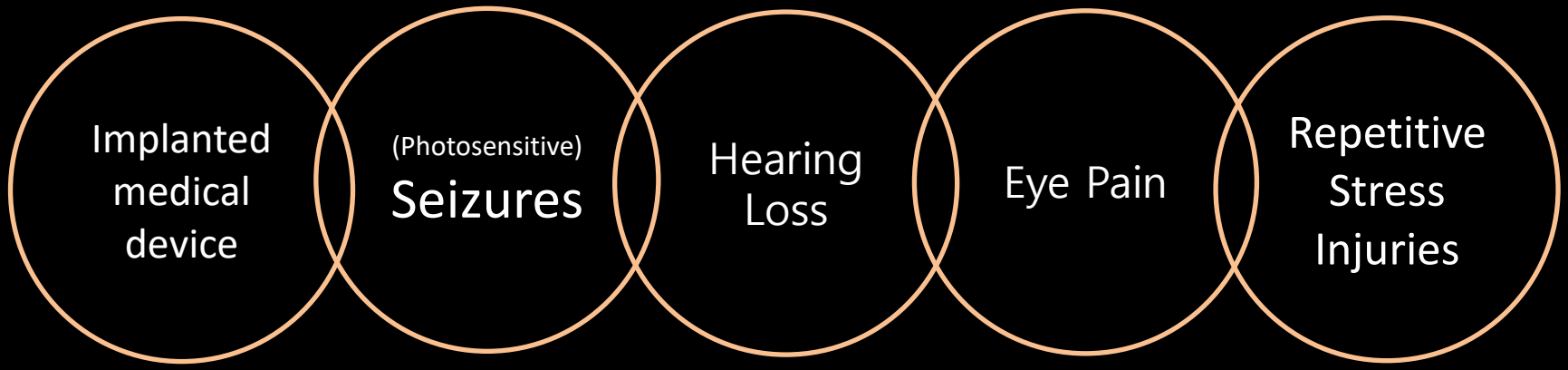
1. Check the guidelines provided by the device manufacturer
2. Make contents for 10-minute lengths
3. Exclude places with ethical controversy and use a vast, dark background.
4. Minimize Text usage.
5. Use color and sound appropriately.
6. Produce contents that can be predicted or sensed in accordance with the synchronization expectation.
7. When creating VR contents, move camera movement at a constant moving speed so that acceleration does not occur frequently.
8. When make and place the virtual objects and UI, maintain proper distance within the range of the user's view and adjust those to the user‘s eye level.
9. Prior to full-fledged content usage, provide an example of the operation method and the content sample.

7

human factor guideline for users

7 for users

#1. Check the status of users

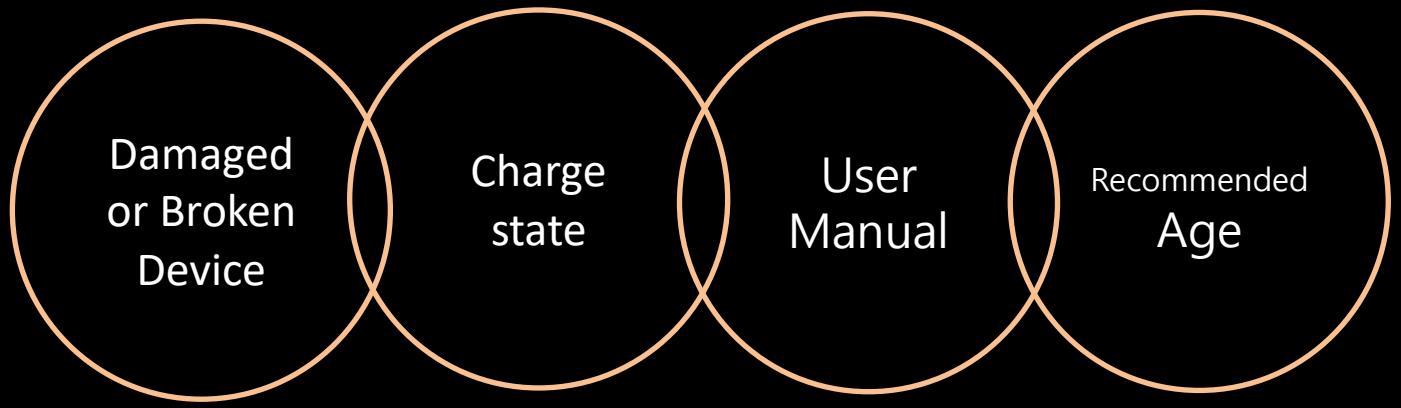


- Consult doctor before use if you have pre-existing serious medical conditions, conditions or if you are pregnant or elderly.
- Stop using if you experience any discomfort.
- If you have serious and/or persistent symptoms after use, see a doctor

※ Source
- https://m.veryicon.com/icons/system/ios7-minimal/basic-listen.html

7 for users

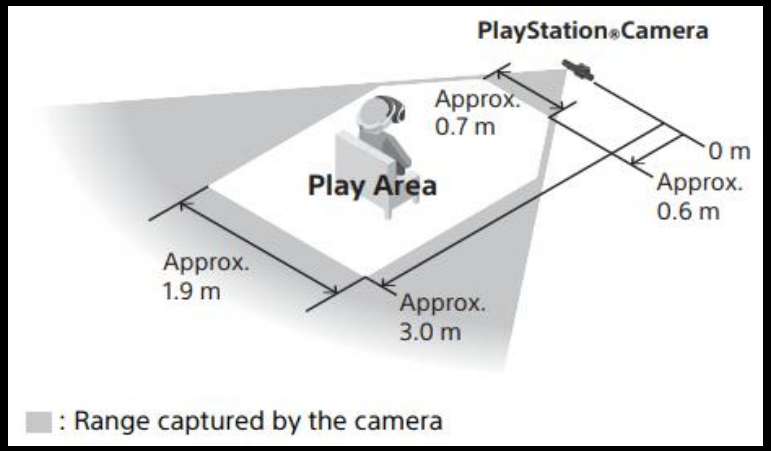
#2. Review the H/W and S/W recommendation for use

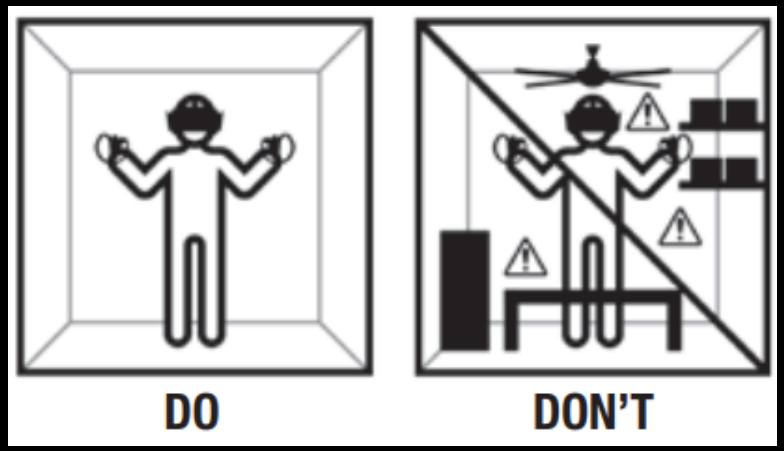


- Due to differences in how to use each device, it is recommended to verify the user manual in advance for safe use.
- For K-12 students, it is recommended that the standard be used as conservatively as possible.

7 for users

#3. Use only in a safe environment





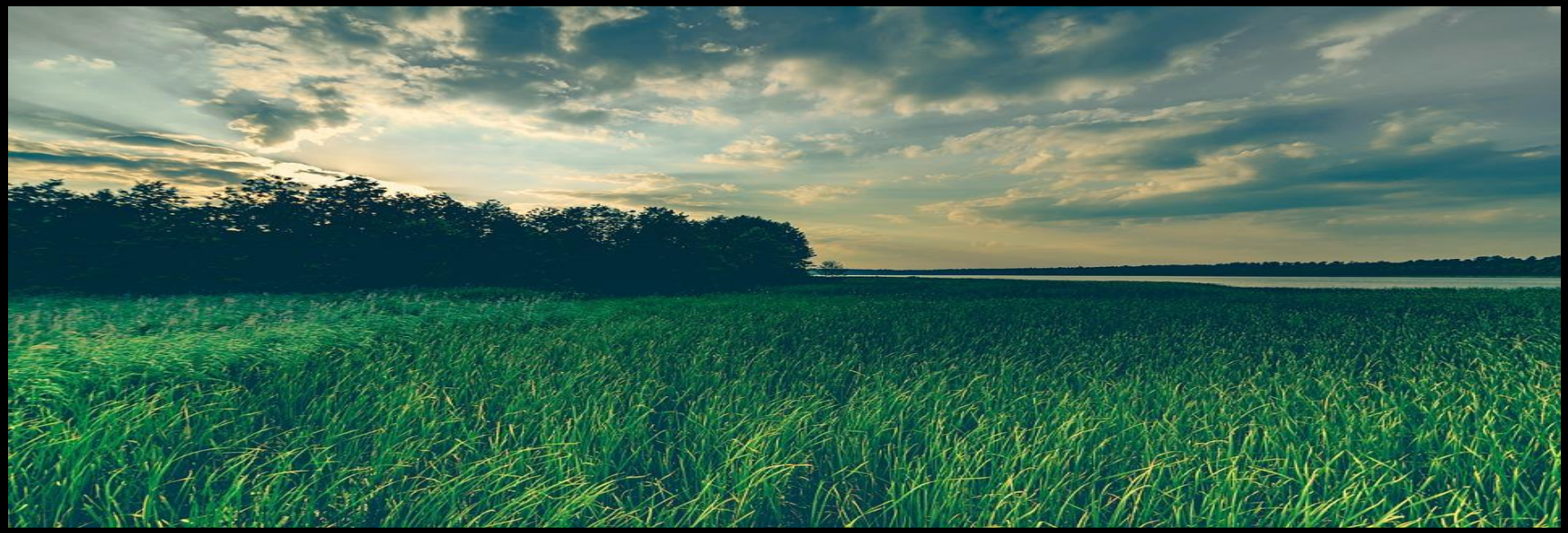
- Review surroundings and clear obstacles from an area larger than the play area before use.
- Remain seated unless your content experience requires standing.

※ Source

- https://www.playstation.com/en-au/content/dam/support/manuals/scee/web-manuals/ps-vr/PSVR_Instruction_Manual_ANZ_Web.pdf/
- https://static.oculus.com/documents/310-30023-01_Rift_HealthSafety_English.pdf

7 for users

#4. Take frequent breaks during use



- Takes at least a 10 to 15 minute break every 30 minutes, even if you don't think you need it.
- Takes more frequent and loner breaks if you fell discomfort.

※ Source : https://pixabay.com/ko/%ED%98%B8%EC%88%98-%ED%95%98%EB%8A%98-%EB%B0%98%EC%82%AC-%EB%AC%BC-%EA%B5%AC%EB%A6%84-%EC%97%AC%EB%A6%84-%ED%9C%B4%EA%B0%80-mazury-%ED%8F%B4%EB%9E%80%EB%93%9C-1611044/

7 for users

#5. Be careful about burns caused by heat of device

- Almost of devices often work close to the body.
- If excessive heat is generated on the device, it can cause physical damage such as low temperature burns.
- In particular, the elementary and secondary students' skin is vulnerable.

※ Source

- https://pixabay.com/ko/%EA%B5%AC%EB%A6%84-%EC%97%AC%EC%84%B1-%EA%B2%8C%EC%9E%84-%EC%86%8C%EB%85%80-%EB%AA%A8%EB%8D%B8-%EC%95%BC%EC%99%B8-%ED%99%9C%EB%8F%99-%EC%82%AC%EB%9E%8C-%EC%B8%A1%EB%A9%B4-%EB%B3%B4%EA%B8%B0-1845517/
- https://pixabay.com/ko/%EC%A6%9D%EA%B0%95%EB%90%9C-%ED%98%84%EC%8B%A4-%EC%9D%98%EB%A3%8C-3d-%EA%B3%BC%ED%95%99-1957411/
- https://pixabay.com/ko/%ED%96%87%EB%B3%95%EC%97%90-%ED%83%94-%EB%82%98%EC%9A%94-%EC%8A%A4%ED%82%A8-%EB%B9%A8%EA%B0%95-%ED%94%8C%EB%9F%AC%EC%8B%9C-%ED%94%BC%EB%B6%80%EA%B3%BC-%EB%A0%88%EC%BD%94%EB%94%A9-%ED%94%BC%EB%B6%80-%EC%9E%90%EA%B7%B9-2117350/

7 for users

#6. Call attention to distinguish between reality and VR/MR

- Due to lack of cognitive abilities, elementary and secondary students can confuse reality with reality.
- Remember than the objects they see in the virtual environment do not exist in the real environment, so don't sit or stand on them of use them for support.

※ Source

- https://www.roadtovr.com/it-time-we-started-talking-specifics-about-virtual-realitys-future-in-education/
- https://techcrunch.com/2015/11/20/samsung-gear-vr/

7 for users

#7. Monitor children closely during and after use

- Almost of the headset are not sized for children and improper sizing can lead to discomfort or health effects.
- Younger children are in a critical period in visual development.
- Adults should monitor children closely during and after use.

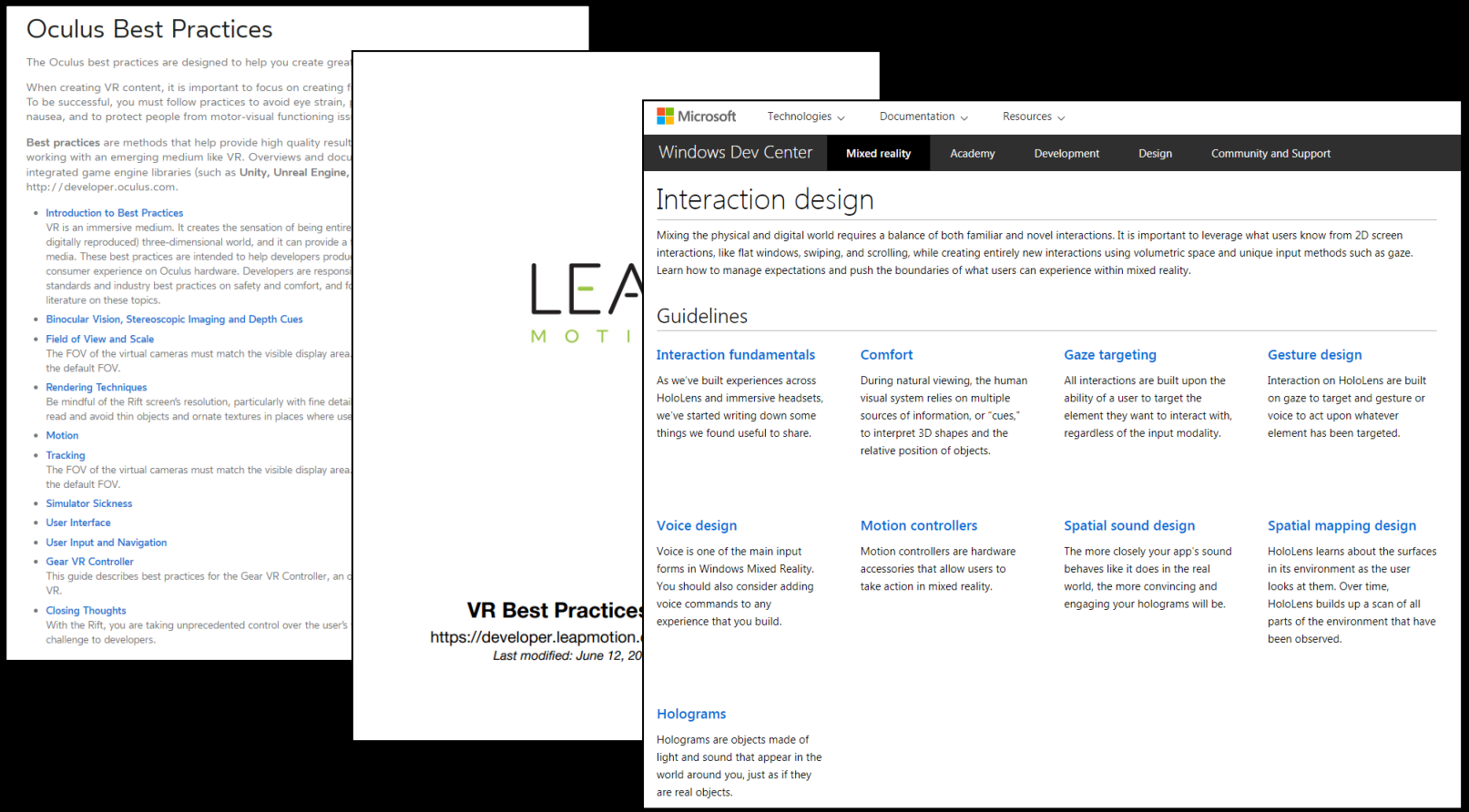
※ Source : https://www.wareable.com/vr/safe-kids-vr-headsets-eyes-development-888

9

human factor guideline for contents creators

9 for contents creators

#1. Check the guidelines provided by the device manufacturer



※ Source

- https://developer.oculus.com/design/latest/concepts/book-bp/
- https://developer-archive.leapmotion.com/assets/Leap%20Motion%20VR%20Best%20Practices%20Guidelines.pdf
- https://developer.microsoft.com/en-us/windows/mixed-reality/category/interaction_design

9 for contents creators

#2. Make contents for 10-minute lengths

Contents with fast screen switching

Contents with smooth progress

※ Source

- http://www.anandtech.com/show/10149/hands-on-with-the-retail-oculus-rift/3
- https://www.roadtovr.com/watch-superchem-vr-cool-virtual-lab-fun-immersive-learning/

9 for contents creators

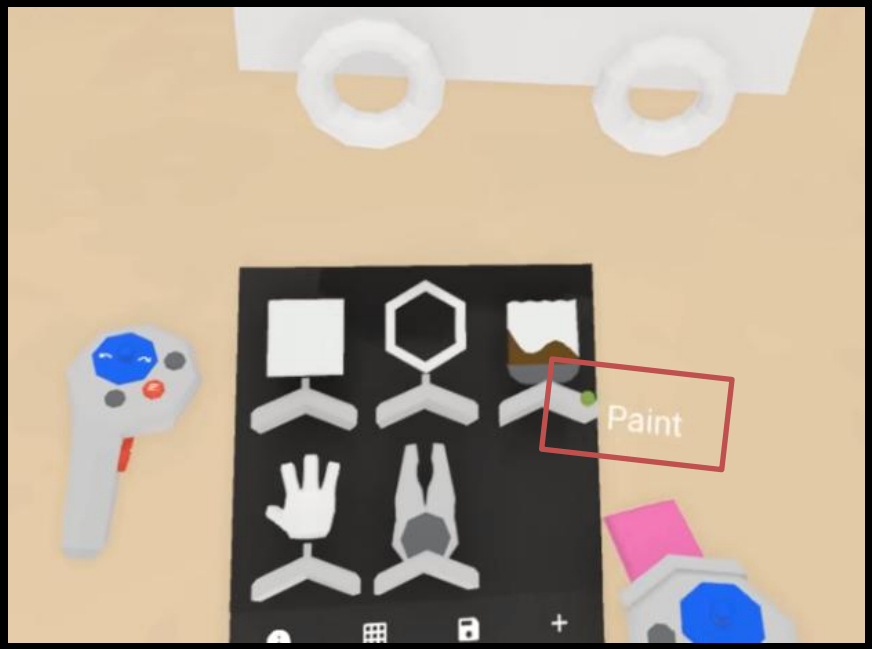
#3. Exclude places with ethical controversy and use a vast, dark background.

※ Source

- https://nextshark.com/pokemon-go-holocaust-museum-koffing/
- https://www.digitaltrends.com/computing/apollo-11-vr-experience/

9 for contents creators

#4. Minimize Text usage

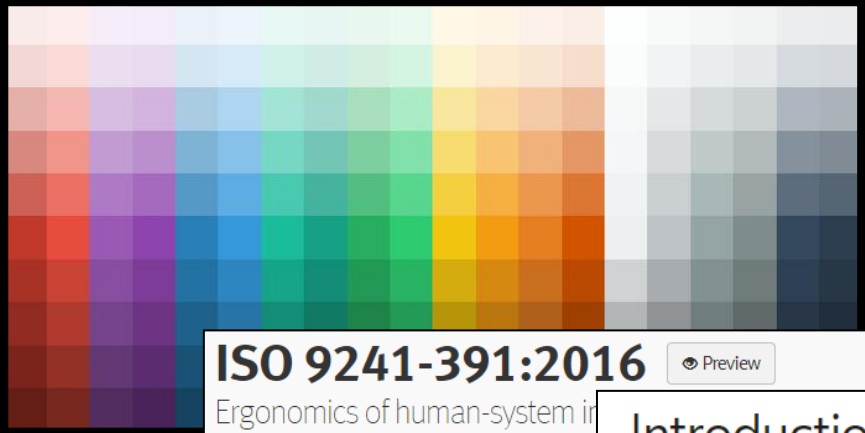


※ Source

- https://livierickson.com/blog/creating-npc-text-for-vr-in-unity/
- https://www.youtube.com/watch?v=BCpNfKmgMF4

9 for contents creators

#5. Use color and sound appropriately.



ISO 9241-391:2016 Preview

Ergonomics of human-system i
reduction of photosensitive seiz

Introduction to Virtual Reality Audio

Welcome to audio development for virtual reality!

This document introduces fundamental concepts in audio development for virtual reality (VR) with an emphasis on key factors that deserve development attention.

Audio is crucial for creating a persuasive VR experience. Because of the key role that audio cues play in our sense of being present in an actual, physical space, any effort that development teams devote to getting it right will pay off in spades, as it will contribute powerfully to the user's sense of immersion. This is as true for small- or mid-sized teams as it is for design houses — perhaps even more so.

Oculus is committed to providing audio tools and technology to developers who want to create the most compelling experiences possible. Learn about, build, and share your VR audio experiences today!

Note: If you are a video producer looking to create spatialized audio for a 360 video, this is the wrong guide. This guide is to help software developers add spatialized audio to VR apps. Instead see Creating Spatial Audio for 360 Video using FB360 Spatial Workstation.

※ Source

- http://htmlcolorcodes.com/color-chart/
- https://www.iso.org/standard/56350.html
- https://developer.oculus.com/documentation/audiosdk/latest/concepts/book-audio-intro/

9 for contents creators

#6. Produce contents that can be predicted or sensed in accordance with the synchronization expectation.

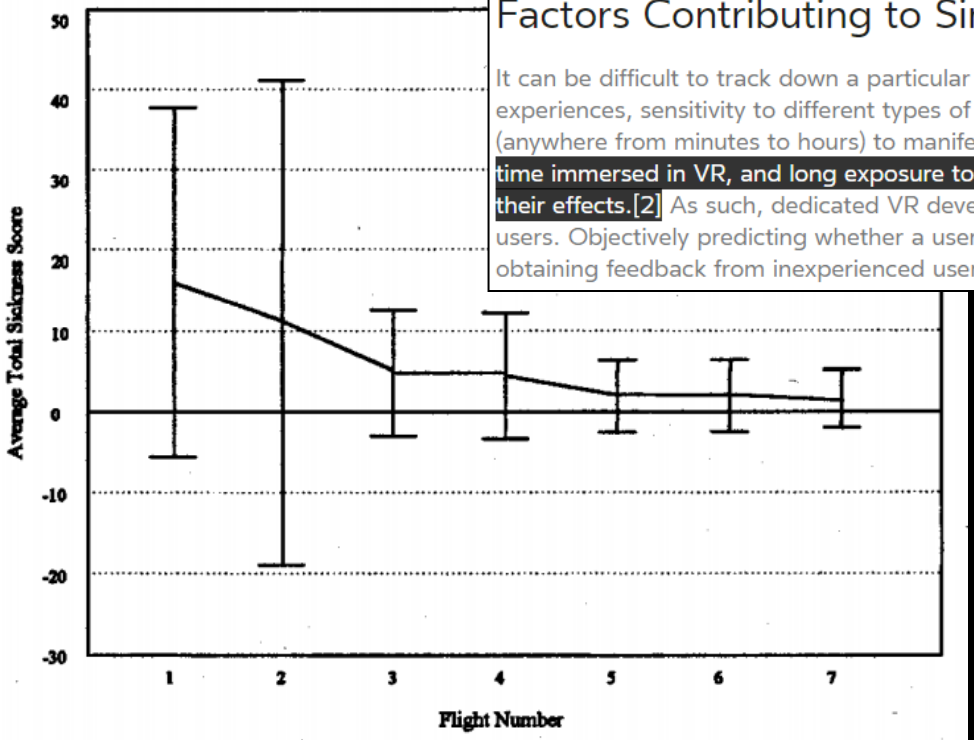


Figure 2. *Mean total reported sickness score, with standard error bars, as a function of number of successive flights in a single helicopter flight simulator.*

Factors Contributing to Simulator Sickness

It can be difficult to track down a particular cause for simulator sickness. Different users will have different experiences, sensitivity to different types of stimuli can vary, and the symptoms can take a while (anywhere from minutes to hours) to manifest. As a VR designer, you will be spending long periods of time immersed in VR, and long exposure to virtual environments can train the brain to be less sensitive to their effects.[2] As such, dedicated VR developers will be less susceptible to simulator sickness than most users. Objectively predicting whether a user will experience discomfort from your content without obtaining feedback from inexperienced users can be difficult.

※ Source

- Kennedy, R., Stanney, K., & Dunlap, W. (2000). Duration and exposure to virtual environments: Sickness curves during and across sessions. **Presence, 9(5),** 463-472.
- https://developer.oculus.com/design/latest/concepts/bp_app_simulator_sickness/

9 for contents creators

#7. When creating VR contents, move camera movement at a constant moving speed so that acceleration does not occur frequently.

Effects of Navigation Speed on Motion Sickness Caused by an Immersive Virtual Environment

Richard H. Y. So, W. T. Lo, and **Andy T. K. Ho,** Hong Kong University of Science and Technology, Clear Water Bay, Kowloon, Hong Kong

This study investigated the effects of navig
ness during and after a 30-min head-ste
squares for 8 speeds in the fore-and-aft a
m/s. Participants were 9ft Chinese men.
increased significantly with speeds increa
exceeding 10 m/s, the ratings stabilized. N
cantly affect the onset times of vection and
increase with duration of exposure.
Questionnaire scores, navigation speed
oculomotor subscore. Actual or potential
prediction of sickness associated with sim
at different navigation speeds.

INTRODUCTION

Motion sickness associated with exposure to virtual environments (VEs) has been the subject of many studies (see reviews in Stanney, Salvendy, et al., 1998, and Wilson, 1996). This type of sickness has been referred to as a type of vection-induced sickness (Hettinger, Berbaum, Kennedy, Dunlap, & Nolan, 1990) and is called *cybersickness* (McCauley & Sharkey, 1992). In a VE, operators can be exposed to moving scenes with a wide field of view in the absence of appropriate physical motion. This may cause the illusion of self-motion in the opposite direction (referred to as *vection*). Such experiences have been reported to be nauseogenic for participants navigating through a VE (e.g., Cobb, Nichols, Ramsey, & Wilson, 1999; Lo & So, 2001; Regan, 1995; Stanney & Kennedy, 1998).

Because vection and sickness can be generated by watching moving scenes in a VE, the effect of navigation speed on the level of cybersickness becomes an interesting line of research. How fast or slow should an operator navigate through

Address correspondence to Richard H. Y. So, Department of
Kong University of Science and Technology, Clear Water Bay,
Vol. 43, No. 3, Fall 2001, pp. 452-461.

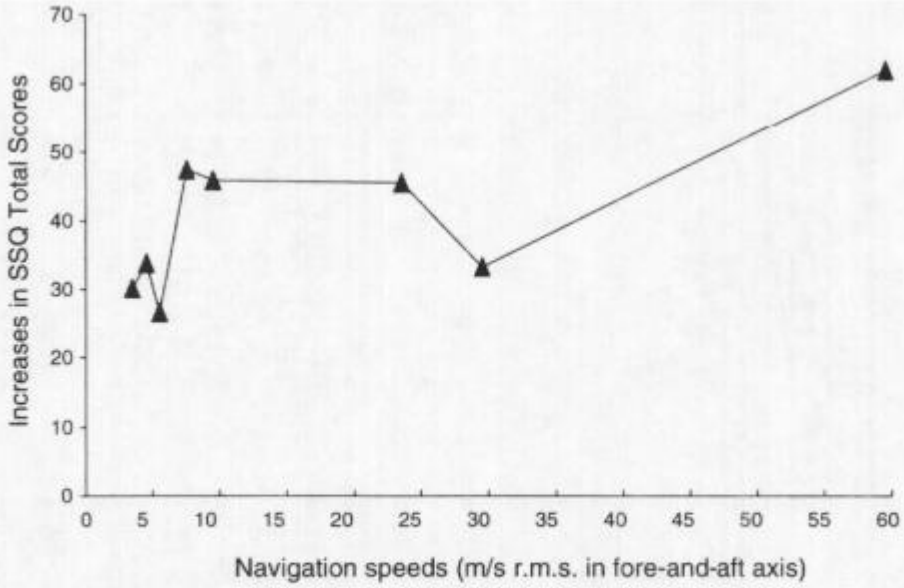
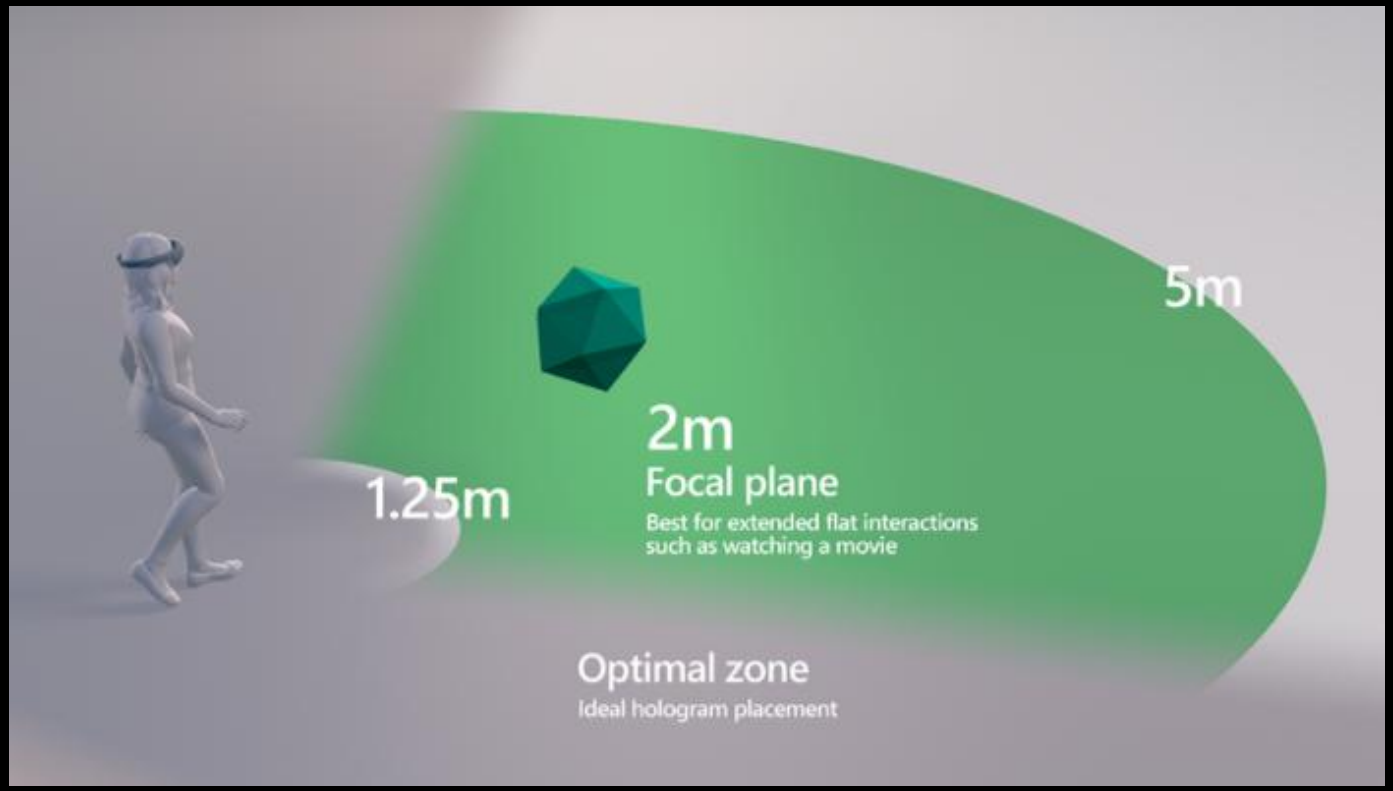


Figure 5. Increases in total sickness severity scores measured by the Simulator Sickness Questionnaire (SSQ) after a 30-min navigation tour of a VE at different scene velocities (as indicated by the RMS scene velocity in the fore-and-aft axis).

※ Source : So, R.H.Y., Lo, W.T., & Ho, A.T.K. (2001). Effects of navigation speed on motion sickness caused by an immersive virtual environment. **Human Factors, 43**(3), 452-461.

9 for contents creators

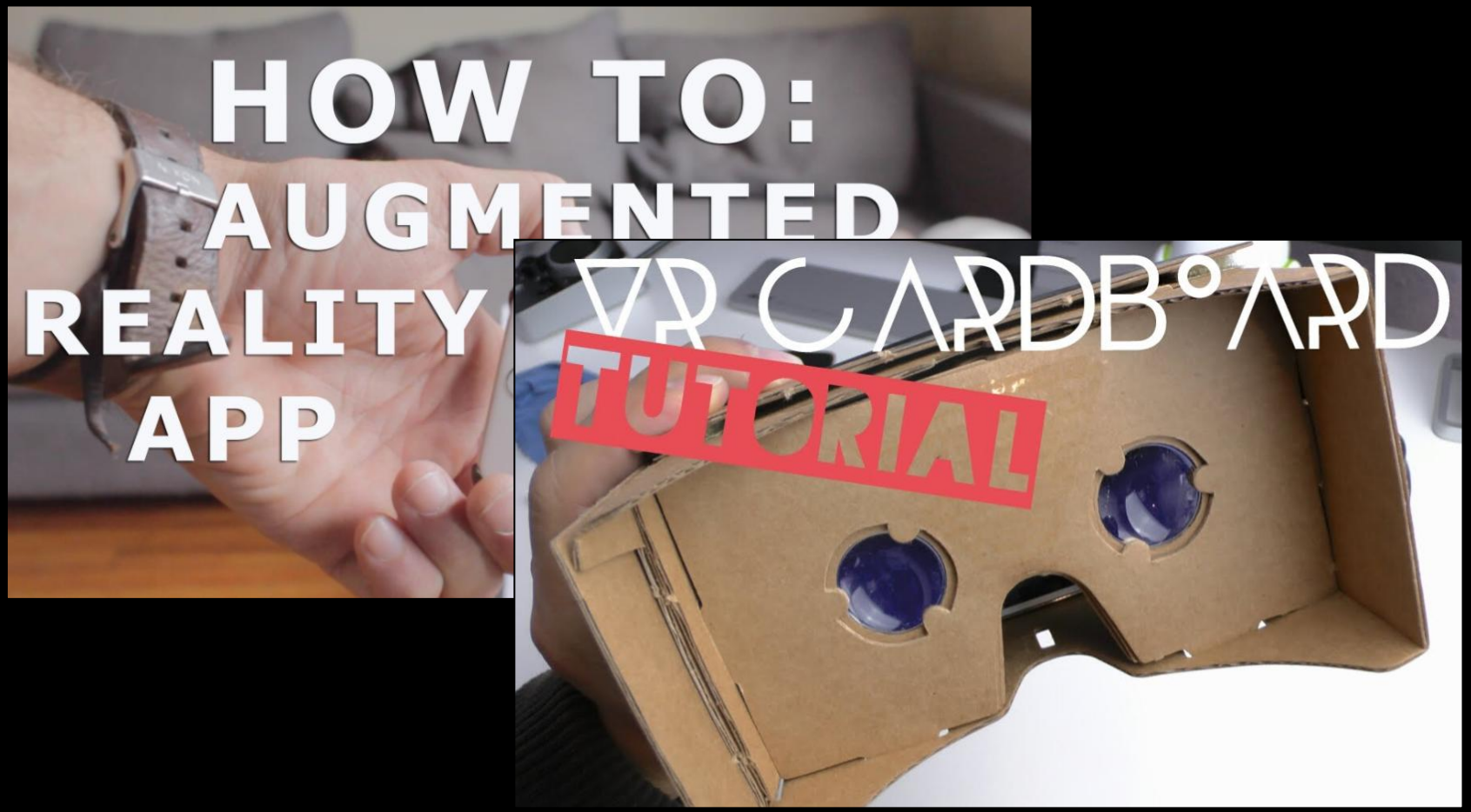
#8. When creating VR contents, move camera movement at a constant moving speed so that acceleration does not occur frequently.



※ Source : https://developer.microsoft.com/en-us/windows/mixed-reality/comfort

9 for contents creators

#9. Prior to full-fledged content usage, provide an example of the operation method and the content sample.



※ Source

- https://www.youtube.com/watch?v=uXNjNcqW4kY
- https://www.youtube.com/watch?v=3OUeGI4FUUk

Future work

Thank you