# FACT$^2$ Mixed Reality Task Group
# Final Report 2018

Mixed Reality (MR) is comprised of Augmented Reality (AR), Virtual Reality (VR) and arguably, 360-degree video. AR and VR are in use in numerous commercial applications from Pokémon Go to the NY Times. These tools have serious implications for higher education in areas that include virtual labs, student engagement, and student success and retention.

## Charge

The charge of the SUNY FACT$^2$ Mixed Reality Task Group was to explore the use of Mixed Realities in the higher education setting and analyze the opportunities they offer to enhance the teaching, learning, and professional development experiences of students and faculty using the following paths of inquiry.

- What are the opportunities for these emergent tools to be integrated into higher education outcomes?
- What training, tools and hardware are needed to initiate and support integration into teaching and learning?
- Describe the learning curve to optimize course and degree outcomes.
- Is there enough research and experience to frame the potential benefits of these tools in fully online, hybrid and conventional modalities?

## Goals

- Recruit collaborators from SUNY and beyond (faculty, instructional designers, content and product manufacturers) who have subject matter expertise and experience with a goal to augment and expand teaching and learning opportunities that can be sustained as a CoP.
- Research effective strategies for creating and sustaining a CoP.
- Create special interest group that will explore tools and methods being developed to support course and degree outcomes and lay the groundwork for a CoP.
- Share the Task Groups' Workplace pages

## Expected Outcomes

- Community of Practice (CoP VR) will be formed to continuously explore, collaborate and share their findings as resource to the SUNY system
- Communication Strategy to actively provide information (using a FACT$^2$ website), with quarterly summative reporting to the FACT$^2$ Council.
- Create a repository of content that includes: past reports, case studies, resources and an active list of AR/VR resources that would be regularly updated, evaluated, reviewed, and changed as the technology evolved.
- Form partnerships with colleges and groups like COTE, CPD and others to share information and to be a persistent resource for all stakeholders.
- The CoP would present and discuss issues at major events like CIT and the FACT$^2$ Symposium
- Prepare cost/benefit analysis to explore the feasibility of deployment and training.
- Publishing to SUNY and possibly in a Journal
- TG Finale **Fall 2018 Symposium (sometime in Nov)**

## Members

Jeffrey Riman
Nancy Winters
Ibrahim Yucel
John Locke
John Zelenak
Amanda Hollister
Michael Reale
Lauren Williams
Jolanda Tromp
Richard Lamb
John Kane

## Organizational Framework

- **Action research** with volunteer; faculty, instructional designers and students
- **Teaching:** What can/should we do now, in the near or distant future in the education space
- **Learner**: How will learners of all ages use these tools in and out of the learning space.
- **New Skills**: How will these new skills change certificate and degree program requirements.
- **Content Creation:** Tools to create content to meet specific needs. Open source and proprietary
- **Career Skills:** How will these tools impact the workplace. Worker skills that will be in demand.
- **Sustainability:** What is required to keep these tools up to date.
- **Examine the emerging cost barrier/benefit** to explore the feasibility of deployment and training in each modality.

## Workflow and Process

Initially, we planned to divide up the task group into two segments (figure 1). First; a group dedicated to exploring primary research and related tools and methods. The second group focused on the acquisition of secondary sources that would serve as a library in support of our efforts, ultimately, to be a living resource for all who are interested. A Zotero group was created and populated with writing and resources (figure 2). We soon realized that the content was becoming obsolete shortly after being published. It also became evident that the whole taxonomy in mixed realities was rapidly changing, making organizational strategies time consuming if not daunting. At this point the group paused to reflect on the best path deciding to first focus on the active use of mixed reality tools in the teaching and research spaces. This allowed us to collect data from early adopters whose experiences would inform our strategy. Later in the process we would revisit secondary research, communication and community development.

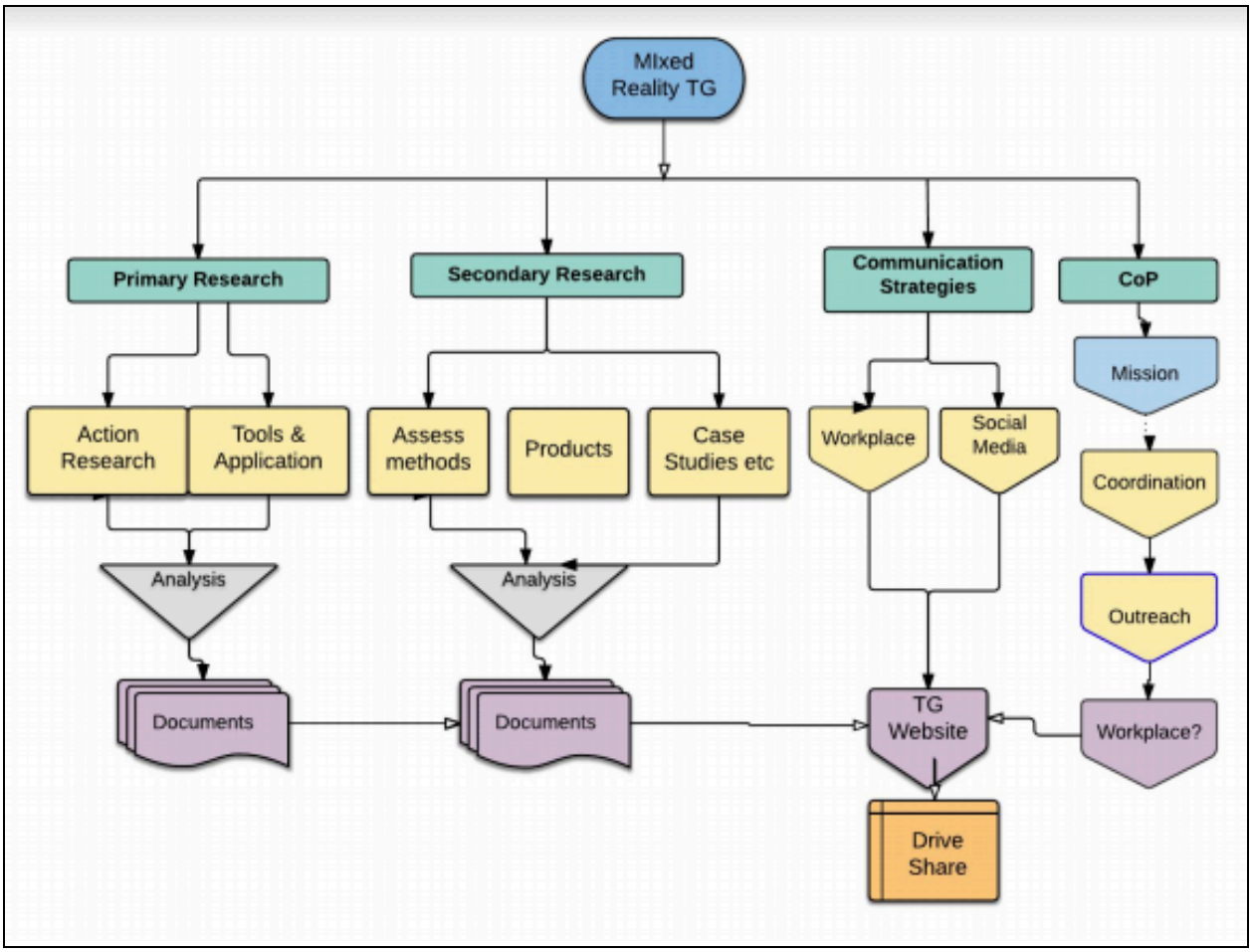


Figure1: Task group projected workflow.

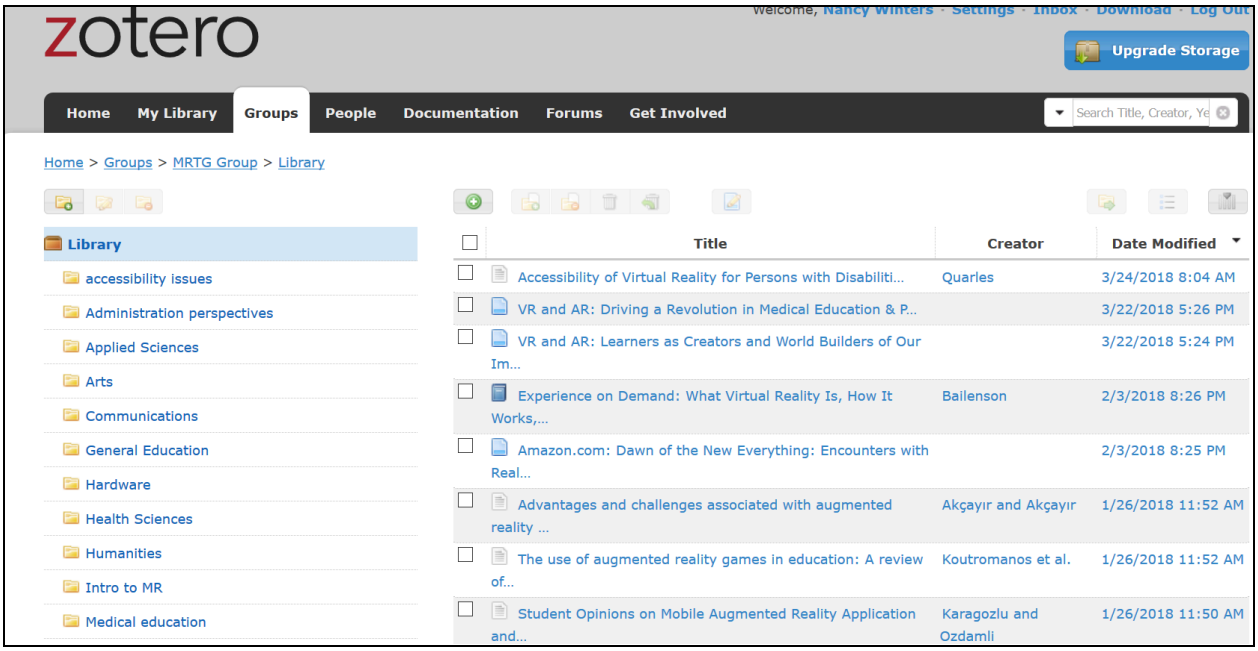


Figure 2: Detail from Zotero group.

## Meetings

The Task Group met a total of 20 times throughout the 2017-2018 academic year.

## Executive Summary

To help accomplish the goals of this committee, the Task Group developed a survey (see Appendix A) to investigate the current uses of Mixed Realities (MR) in higher education and research. The survey was circulated internationally with an emphasis within SUNY. A total of 123 respondents completed the survey. Of these, 35% (43) are currently using some form of MR tools in the classroom. Of the remaining 80, only six stated they planned to use MR in the future, 20 said they had no intentions of using these technologies, and 46 felt that they may consider it in the future. Most of the respondents were in the role of faculty (61%), followed by researcher (22%), and instructional design/support (17%). There were no librarians. Fifty-eight percent of respondents were from a SUNY campus.

Fifty-eight percent of respondents are currently employed by a SUNY school covering the following campuses: University at Albany, Binghamton University, University at Buffalo, SUNY Delhi, SUNY Downstate Medical Center, Empire State College, Fashion Institute of Technology, Finger Lakes Community College, SUNY Geneseo, Maritime College, SUNY Old Westbury, SUNY Oneonta, SUNY Plattsburgh, SUNY Potsdam, Purchase College, Stony Brook University, SUNY Polytechnic, and SUNY Ulster. Non-SUNY representation (42%) includes Canada, UK, Germany, Ireland, Massachusetts, Colorado, Italy, New Zealand, Scotland, California, and Australia.

## Executive Summary *continued*

MR is being used successfully in classrooms and in research. Respondents identified some challenges in implementing MR in their work with a majority reporting student reluctance, faculty reluctance, and lack of infrastructure and hardware as significant challenges. In narrative form, several faculty respondents expressed concern over perceived value of this technology. However, there was a significant reduction in perceived value concerns by the research respondents. Poor user experience, difficult to use hardware and software, and lack of educational content were the least identified challenges identified by respondents.

When looking at the lowest ranking challenges it's clear that respondents think there is high quality educational content available but that a lack of infrastructure, hardware and software exists potentially adding to their reluctance to use MR experiences in the higher education classroom.

Specific examples of current use in the classroom include: At SUNY Plattsburgh and SUNY Delhi, nursing faculty currently use several virtual reality simulations via external vendors such as VSim, SimPractice, and Shadow Health. These types of simulations are used to increase safety in the clinical environment and mostly used as independent lab homework outside of the classroom. Similarly, at SUNY Ulster, nursing faculty are using and electronic health record through Evolve for simulation experiences.

Those that are researchers in MR have interests in multiple areas. For example, at SUNY Polytechnic, one researcher is using VR to study anatomy with Vive. Another researcher at this college researches the use of MR in education and game design.

## Outcomes

At the outset our goals were very broad and the development and use of mixed realities in education is still in its infancy. As a task group we found we were exploring the beginnings of a new evolutionary stage in the synthesis of teaching with technology. Our group was a mix of people currently researching and those who are interested in learning more. The former represents the majority of teaching faculty, many who are skeptical about the value of these new tools. As you will see in the survey results there are many perceived and imagined barriers to success. Other significant outcomes are described below.

**FACT$^2$ Symposium: Virtual Immersive Pedagogy** is planned for November 9th to be held at SUNY Admin in the Zimpher Boardroom. This one day event has a call out for presenters and will feature an exposition where speakers will share their work in a hands-on environment.

**CIT VR Expedition** Presentation on the use of VR in some teaching settings. Led by UB Professor Richard Lamb and Co-sponsored with CrossWater. Attendees were briefed on current examples and given a set of Google Cardboard to experiment with. This event was held twice during the conference.

A **Zotero Group** was created and populated with materials which will serve as a prototype for future efforts.

**A Community of Practitioners:** A Workplace Group has been created and was softly launched in June 2017. The upcoming symposium will host the formal launch. This is a multi-company group which is open to all of SUNY and can also accommodate non-SUNY participants with a manual enrollment plan.

## Use in Classrooms

At Maritime College, the Marine Transportation department is using this technology to teach vessel operations in their Bridge Resource Management course. The Full Mission Bridge Simulator is to simulate the vessel in different scenarios.

At SUNY Potsdam, software such as View Master VR, Richie's Plank Experience, Google Earth VR, and Tilt Brush are used in their Teaching and Learning with Simulations and Games course. Right now, it is mostly being used as an extracurricular activity to allow students to experience the "presence" and spatial relationship that this technology gives. One student developed a Google Cardboard lesson wherein the class explored the ruins in Athens.

At SUNY Plattsburgh and SUNY Delhi, nursing faculty currently use several virtual reality simulations via external vendors such as VSim, SimPractice, and Shadow Health. These types of simulations are used to increase safety in the clinical environment and mostly used as independent lab homework outside of the classroom. Similarly, at SUNY Ulster, nursing faculty are using and electronic health record through Evolve for simulation experiences.

At SUNY Old Westbury, the New Media in Action course is using Aurasma for augmented reality projects. This is done with creative 360-degree videos. They are assessing student learning using rubrics. Faculty teaching Wave Motion and Methods and Materials of Teaching Science use Vernier, Backyard Brains, Wolfram Mathematica, and PhEt Interactive Simulations for classroom discussion and experimental tasks.

At SUNY Geneseo, the Introduction to Museum Studies course is using Google Streetview, Expeditions, and Unity. In addition, they use 360-degree videos on planetarium dome. They are using this technology to give virtual tours, immersive psychology experiments, and capturing remote locations and experiences.

Purchase College is incorporating 360-degree video experiences into advanced video classes using Adobe Premiere, 360Fly, Theta S, and other phone applications. Another faculty is teaching Unity 3D in a New Directions in Virtual Spaces course. In this course, several of the senior students are using Vive to complete their final project.

At Empire State College, one faculty member reports using virtual reality in the online classroom using Open Simulator / Second Life. It is used mostly for virtual-reality meetings, classroom experiences, poster sessions, and student presentations. Students also develop their own projects using 360-degree cameras and open source software using Kitely.

At the University of Massachusetts, Music Department faculty are using Ambeo A-B, Ambeo Orbit, and React VR in their Audio Theory to create engaging educational experiences.

At the University of Colorado, faculty in the Music and Entertainment Department are using Google Cardboard with Reaper, Pro Tools, and FB360 in their Introduction to Sound Design course to give an overview of psycho acoustics.

At the Fashion Institute of Technology, Instructional Design/Support use Google Cardboard and Tiltbrush for faculty development and experimentation. Tiltbush was used in Anatomy for Artists where

students used Tiltbrush to draw muscles and their attachments on to a 3d rendering of a human skeleton.

In California, Instructional Design/ Support has aided with integration of several free or low cost ($2.99-$29.99) MR software options into multiple different courses (astronomy, gaming, neurosciences, electrodynamics, optics and lasers, nursing, engineering, journalism, media and technology, photography, visual communications, and media).

Outside of the US, in Ireland, faculty in the computer science department are integrating MR into their Interactive Media, Digital Humanities, and IT courses. Specifically, using UE4, Unity, WebGL, Three JS, WebVR/XR. They are using this technology to teach VR/AR/MR systems development. They are researching multimodal interaction and user measurement in VR/AR/MR.

In the UK, some game engines (Unity and Unreal) and applications (Virtual Battlespace 3, Elite: Dangerous, Google Tilt Brush, Google Blocks, Fight Simulator X, Project Cars) are used in their Department of Defense and Security. They use the technology to show students that the right technology must be used to solve particular issues.

In Italy, faculty in the Psychology of Technology course are having students develop VR experiences using Unity and InstaVR.

In New Zealand, faculty teaching medical imaging have replaced the usual simulation experiences with VR experiences related to patient positioning.

In Canada, faculty are researching the use of 360 Storytelling for journalism. And, in a School of Media & Design, faculty are using Rumii and Unreal Engine 4 to teach students to make basic VR games and hold VR conferences for collaboration. Faculty at another Canadian college are using custom content solutions to teaching anatomy and physiology.

## Use in Departments

- Info Technology, 3
- Marine Transportation
- Nursing, 6
- Business
- American Studies
- Comp & Inst. Tech, 3
- Distance Learning
- Dig Com & Media, 5
- Computer Science, 2
- Music & Enter, 2
- Defense and Security
- Psychology
- Student Exchange
- Electrical Engineering
- Education, 3
- School of Arts, 2
- Chem/Physics/Bio, 2
- Academic Affairs

## Use in Courses

- Project management
- Quantitative Methods
- Engineering Eco
- Bridge Resource Mgt
- IT: Teaching and Learning with Simulations and Games
- Nursing: Health Assessment
- New Media in Action, Interactive Media
- Introduction to Museum Studies
- Anatomy & Physiology
- Digital Humanities
- Audio Theory
- Defense Simulation
- Modelling Simulation Employment Training
- Psychology of Technologies
- Medical Imaging
- News Production
- Digital Production
- Interactive Project, Proseminar
- VR environments
- House building
- Wave Motion
- Principles of Astronomy
- Neurosciences
- Electrodynamics
- Modern Optics and Lasers
- Journalism
- Game Design
- Photography

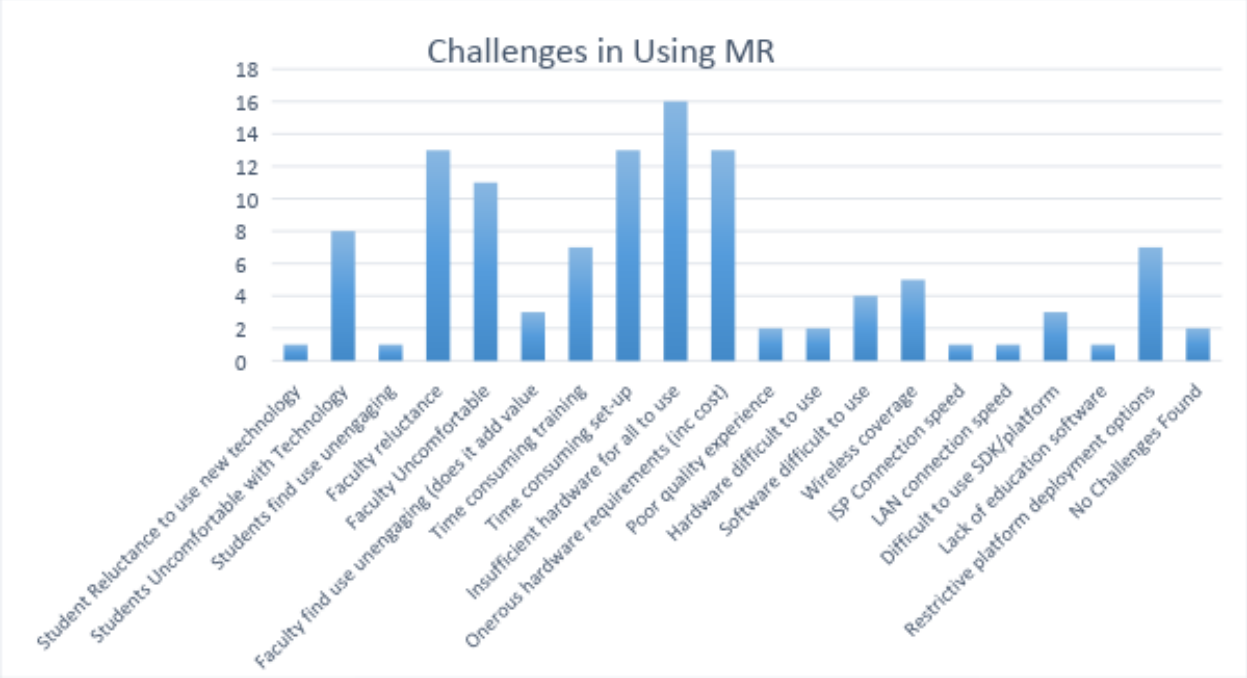


Figure 3: Respondents reported challenges for using MR in the classroom. Highest ranking challenges included student and faculty reluctance, and insufficient infrastructure and hardware. Lowest ranking challenges included difficulty in use and lack of content.

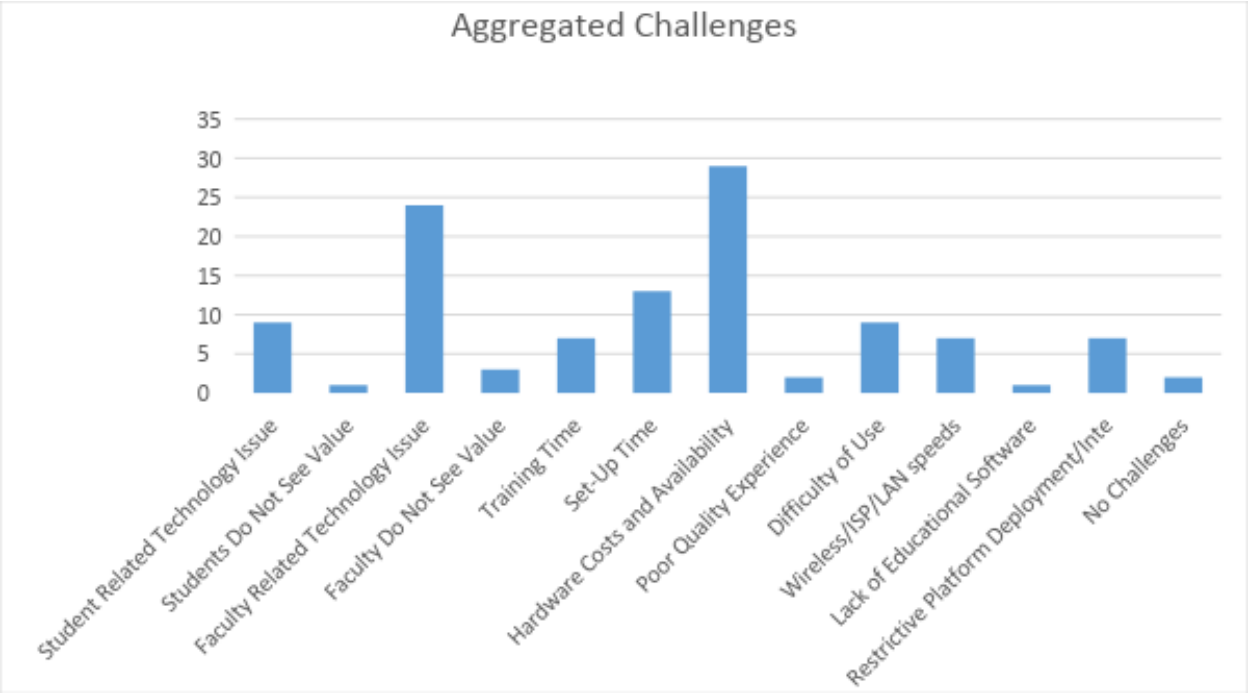


Figure 4: Challenges shown by logical grouping. Highest ranking challenges include student and faculty related technology use, and costs. Lowest ranking challenges include students and faculty do not see value in MR experiences, and lack of content.

## Examples of Research in Action

Those that are researchers in MR have interests in multiple areas. These areas are best described in terms of their scope and perspective on MR. The first area of focus is the development of hardware and peripherals to improve the immersion of the participant. Second is in the development of tools to create content in MR. Finally, the last area of research is in the use of MR in a variety of contexts.

The majority of the research seen at SUNY institutions is focused on this third perspective. Researchers at university research centers see the opportunity the recent reduced cost of MR has for professional and educational purposes. Below are some examples from our survey of the work being done at SUNY and other higher education institutions.

For example, at SUNY Polytechnic, and IITG grant is investigating commercially available VR solutions in a case study. They Study utilized Organon VR software to help students study anatomy with the HTC Vive headset. They are expanding from this case study to create a more generic Augmented reality learning space, where instructors will be able to create lesson plans around 3d objects that can be seen on multiple interfaces. Another researcher at SUNY Poly is investigating the use of MR in physics education.

At SUNY Oneonta, one research described the use of Second Life as a concert venue, as well as augmented reality in the chemistry laboratory.

In Canada, a researcher is interested in the psychological impact of “perceived” environmental immersion in the areas of medical/health/treatment, training, simulation, visualization, entertainment/gaming, and epigenomic mapping. Funding was reported as the biggest challenge.

In the UK, a researcher is focused on digital publication using Mix Autodesk Suite, Blender, Adobe Suites, and Unreal. The biggest challenges reported were onerous hardware requirements, and difficulty in using both hardware and software. Another researcher is interested in the use of MR in clinical simulations, rehabilitation, and mental health. Having insufficient hardware for all students is a major concern. In yet a different college, a researcher is interested in the use of VR/AR/MR in defense, healthcare, heritage, outreach, and public engagement.

In Germany, the use of VR/AR for companies, enveloping concepts of applications, and new forms of journalistic storytelling is an area of research interest. This researcher is using Hololens, Vive, and Google Cardboard.

In Australia, a behavior change researcher is interested in using MR to encourage non-violence in young males. This researcher is using Unity, Oculus Rift, and Samsung Gear VR.

## Hardware

Interestingly, while Magic Leap was still the least used hardware for researchers (11%), both the Vive (67%) and Oculus Rift (67%) were used more often than Google Cardboard (56%) in this group. Other hardware used included PlayStation VR, Windows Mixed Reality, Meta2, Vive Focus, Samsung Odyssey, PSVR, Manus, and Senso Gloves.

## Challenges Described by Researcher Respondents


Figure 5: Research categories for which respondents reported use of MR.

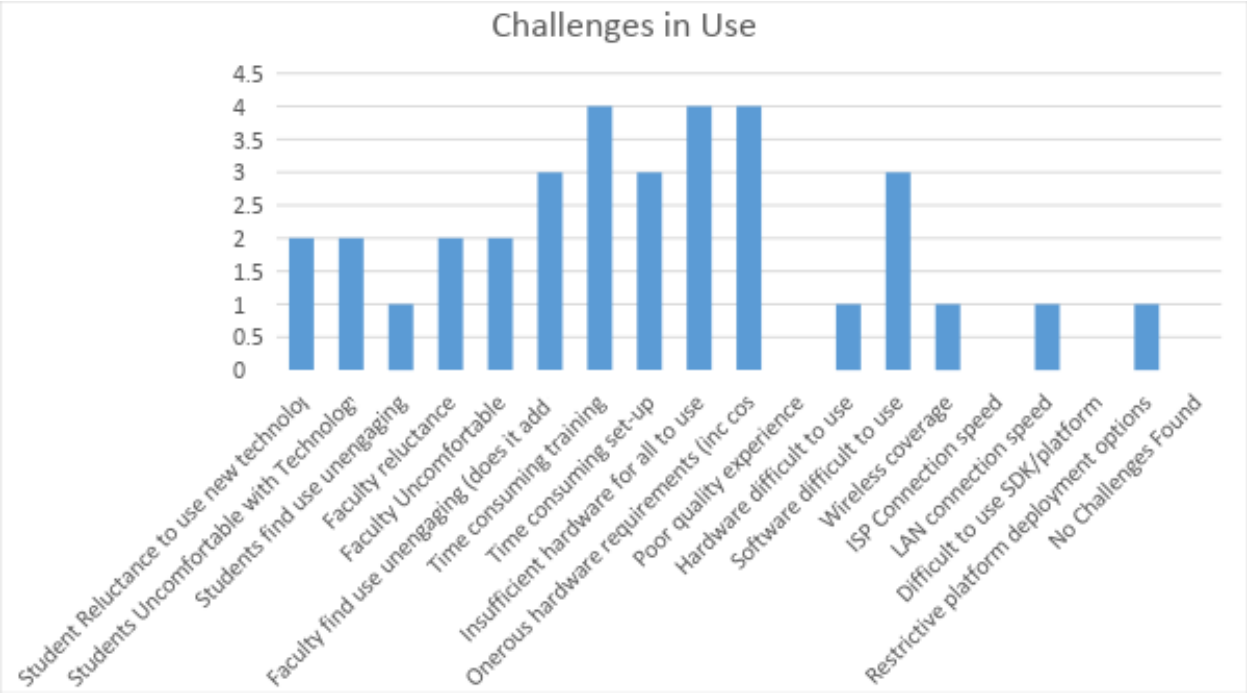


Figure 6: Researcher reported costs and use value has the highest ranked challenges and ranked poor quality experience and difficult to use platform as the lowest challenges.

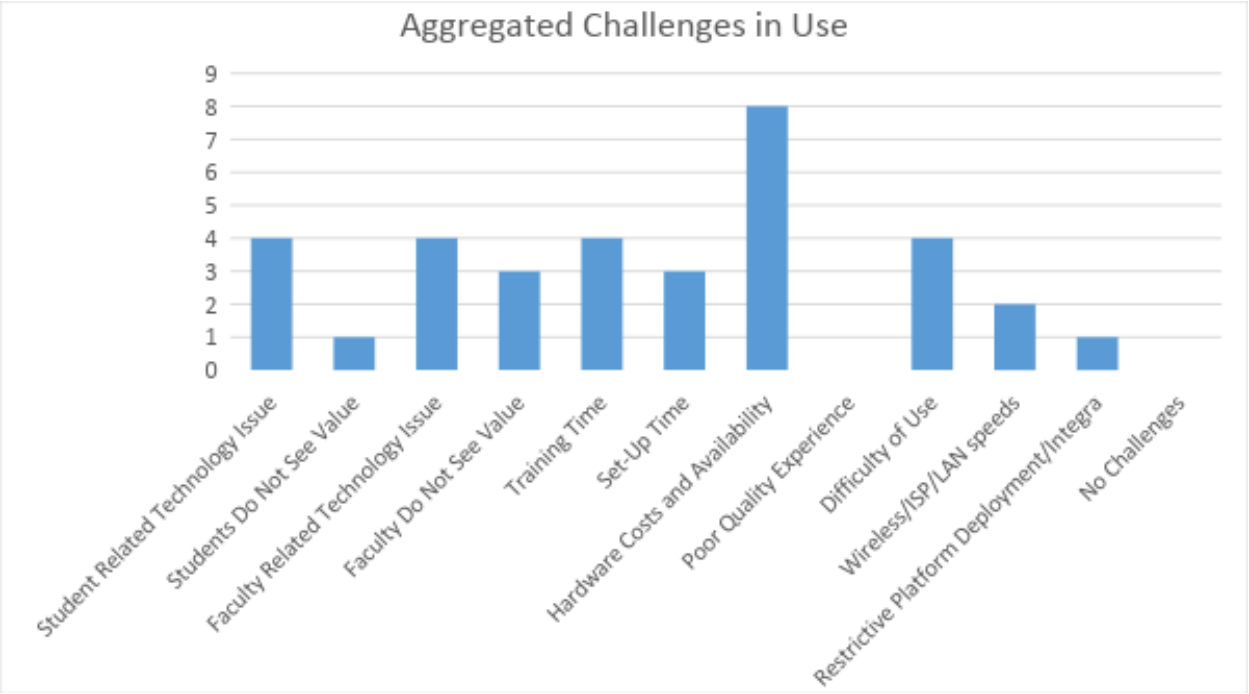


Figure 7: When logically grouped, costs remain the greatest challenge identified by researchers.

## Hardware in Use for Classrooms and Research

Google Cardboard is currently being used by many of the participants (41%) likely due to its inexpensive costs. Magic Leap was the least used hardware (4%). Other hardware included Hololens (15%), Vive (33%), Oculus Rift (33%), and Samsung GearVR (26%). Several respondents added some additional hardware that they are currently using:

- Full Mission Bridge Simulator
- Virtual Reality Simulations via external vendors (Elsevier, Lippincott, Shadow Health, Laerdal)
- VSN Mobil V.360 Panoramic VR
- 360-degree video on planetarium dome
- Sennheiser Ambeo
- MetaVR
- Hololens
- Gear 360
- PrioVR
- GoPro Fusion
- Insta360Pro
- 360 Fly
- Theta S
- Google DayDream
- Microsoft MR headset
- Vernier
- Backyard Brains

## Software in Use for Classrooms and Research

- Simulator Specific
- Viewmaster VR
- Richie's Plank Experience
- Google Earth VR
- Tilt Brush
- VSim
- SimPractice
- ShadowHealth
- Aurasma for Augmented Reality
- Google Streetview
- Expeditions
- Unity
- Hololens
- UE4
- Unity
- WebGL
- ThreeJS
- WebVR/XR
- Ambeo A-B
- Ambeo Orbit
- React VR
- Unity
- Unreal Apps (Virtual Battlespace 3)
- Google Blocks
- Flight Simulator X
- Project Cars
- Reaper
- Pro Tools
- FB360
- InstaVR
- Premier Pro
- Oculus
- Gear 360
- Adobe, Blackboard, Zoom
- Virtual environments – Open Simulator, Second Life
- Anatomy and Physiology – custom content solutions
- Bespoke
- EHR from Evolve
- Adobe Premiere
- Kitely open source virtual reality software
- Vernier
- Backyard Brains
- Wolfram Mathematica
- PhEt Interactive Simulations
- VR Museum of Fine Art
- Engage
- Metaverse Construction Kit
- VertoStudio 3D for HoloLens
- Surgeek Virtual Surgeon
- Apollo 11
- PaintLab
- Speech Trainer
- Universe Sandbox and Start Chart
- The Body VR
- Nano-One
- Stanford Ocean Acidification Experiment
- Calcflow
- The Lab
- AHS Fearless VR Experience
- Gnomes & Goblins
- Space Tours VR
- Stonehenge VR
- Facebook Spaces
- GoPro Fusion Studio
- Rumii
- Unreal Engine 4

## Anecdotal Responses about Challenges

As part of our charge to understand if VR is viable for use in SUNY classrooms, we asked our participants to tell us what challenges they saw to the adoption of MR. The question was in a short answer format and the responses were coded to the following categories.

| **Code/category of response** | **Number of matching responses** |
|---|---|
| Not sure how to integrate into teaching | 10 |
| Funding and/or support (including need to update computers on campus) | 9 |
| Not sure if university plans to use | 3 |
| Feels they are already doing simulations | 3 |
| Does not feel that curriculum would be enhanced in any way | 1 |
| Investigating the viability | 1 |
| Needs to be easy to use | 1 |
| Might use for non-traditional lab experiences | 1 |
| Would like to use for game design in Unity using VR perspective to explain 3D using two lenses | 1 |
| Concerned about accessibility | 1 |
| Would like to develop AR models to overlay some field sites visited in Geology | 1 |

Many of the responses are expressing a concern that MR is still too expensive or that the technology is unproven. Studies such as this one, the Mixed Reality symposium, and other exhibitions such as Games for Change and XRDC (eXtended Reality Developer Conference) will be showcasing the possibilities of the technology and hopefully will begin to change the anxiety around its use in the classroom.

The cost of MR will mean at this juncture that it's use will most likely focus in areas that it proves savings over alternative learning tools or in areas where we see market growth. This implies we will see a focus on more healthcare and entertainment applications in the near future.

## Conclusion and Future Plans

### Perspectives

Mixed Reality tools present us as educators with a great opportunity to enter the arena while it is still possible to influence the outcomes and grow. While there are many challenges associated with the development and implementation of new technologies the potential gains are enormous as interactivity and experiential learning shift to a new level of complexity. Barriers of entry include the cost and time needed training faculty and staff to support and teach with AR and VR products. Faculty resistance to new technology is also a factor given the demands of effective teaching and the time needed to learn new methods. There have been some efforts in SUNY to introduce faculty to new products. In 2016 a SUNY-wide pilot offered faculty the opportunity to try Labster lab modules for a 1 month period. *(Labster is an online Lab available in desktop simulation and in VR form.)* More than 130 faculty participated in which 33 filled out a post-pilot survey. The responses were heavily skewed against adoption with just 17% in favor of adopting the Labster virtual lab product for their courses. Since that time Labster and many other products have evolved and improved meaning that the past impressions are not a predictor in this case. However those that tested an early version of the product may retain their negative perspective.

Progress has been made as evidenced by commitments made by other institutions outside of SUNY. This spring Drexel University purchased a campus wide license to deploy Labster for its science courses. On May 9, 2018 it was announced that Google has teamed up with Labster to create a VR laboratory which means that colleges and universities will be able to offer fully online, remote courses such as biology. That same month Labster presented at the FACT$^2$ Conference on Instruction and Technology where attendees were invited to sample the VR lab experience. SUNY might want to revisit the use of virtual labs in the sciences in support of online and blended learning.

Equipment costs continue to decline however hardware, especially headgear currently has a projected life of 18 months before newer models render older products obsolete, keeping costs high. VR content designed for education is still in the early stages especially for virtual reality products however augmented reality creation is less costly and easier to produce. Augmented reality tools are increasingly used for self-guided tours, scavenger hunts and for providing detailed instructions on the safe use of equipment in a lab or workshop. Tools to create content are also rapidly evolving gradually making the creation of AR/VR content more accessible to those who are not deeply knowledgeable about coding or user experience design. As the complexities are reduced and accessibility to create, customize and deploy improve the environment for faculty to develop courses that employ new mixed reality tools in curriculum creation.

**Recommendations and next steps**

- **Create a VR/emerging technology track in the IITG grants** targeted to fund efforts that link new mixed reality technologies to effective content creation, development, training and teaching practices.
- **Fostering interaction between researchers stakeholders, and educators.** A SUNY-wide initiative to develop a very robust community of practice that encourages the sharing of research, teaching and learning working with mixed realities products using Workplace. The premise of this CoP will be explored at the FACT$^2$ Symposium which will be held November 9th in the Nancy Zimpher Boardroom in Albany.
- **Fund a SUNY-wide emerging technology demo-space.** Coordinated by CPD and FACT$^2$ This event oriented space would be where researchers and teachers share their efforts and results. This could be embedded within the CoP.
- **Develop/foster open source solutions** for the creation and deployment of mixed reality products that dovetail with the values and benefits of OER. In part this avenue of inquiry will be pursued as part of the goals set forth in the new FACT2 Task Group on Open Pedagogy.
- **Partner with innovators within and outside SUNY** that share our interest in open education strategies and resources. A team devoted to partnerships with educators, content developers, hardware developers and service providers may provide important connections that may lead to a faster pace of innovation and adoption within the SUNY network.