Virtual Worlds
Education Conference

June 5 - 8, 2017

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Keynote Presenters

- **Mr. Ron Weaver** is the Technical Design Director at the Florida Interactive Entertainment Academy at the University of Central Florida. He graduated with Bachelor's degrees in Computer Science and in Religion from Emory University. He later earned a Master's degree in Entertainment Technology from the Carnegie Mellon's Entertainment Technology Center. Mr. Weaver has been a game programmer and designer since 2001. His game credits include: Tiger Woods PGA Tour Online, Toontown Online, Hannah Montana, Family Fusion (Disney Cruise Line), and others. He has developed theme park attractions, websites, interactive television systems, military simulations, mixed reality projects, and museum exhibits. Mr. Weaver has worked with Electronic Arts, n-Space, WDPRO, Orlando Science Center, 360Ed, and Disney Vacation Club.

- **Dr. Len Annetta** is the Taft Distinguished Professor of Science Education at East Carolina University. He has taught high school science, held faculty positions at North Carolina State and George Mason University and served as academic coordinator, Director, Chair of Special Interest groups in Educational Technology, as well as the Executive Director of the Institute for Modeling, Simulations, and Serious Games Research at George Mason University. His research, frequently funded by the National Science Foundation, includes comparisons of different delivery strategies for distance learning, evaluations of video games for education, and the creation of many online virtual environments for teacher training and student education.

- **Mr. Waymon Armstrong**, founder and CEO of Engineering & Computer Simulations (ECS), creates advanced training solutions for military, health care, education, first responder, and other clients. For example, ECS has created the first, fully immersive virtual environment for staff training and patient care at a medical center and a life-saving simulation for training combat medics in point-of-care techniques. Mr. Armstrong and ECS have received many honors and awards, including Military Training Technology Top 100 (2005 – 2015) and the Orlando Business Journal Fast 50 (2016).

- **Dr. William Prensky** is CEO of Chant Newall Development Group LLC, (CNDG), a Gold Solution Provider in *Second Life* and a developer of virtual world simulations for corporate and personal clients, educational institutions, and governmental agencies. Dr. Prensky combines his interests in health care, business, and education as the Chief Technology Officer at the FutureWork Institute to create virtual reality platforms for education and training. His professional background is wide-ranging. This decorated Doctor of Oriental Medicine and Acupuncture was the first American licensed acupuncturist. He was an initial developer of the Peace Curriculum introduced in Swarthmore College in the 1970's and served as Chair of the UCLA Center for the Study of Nonviolence. As a graduate student, William Prensky founded and directed the Intra-Personal Communications Center in Los Angeles. As a business executive, he served as Chair of the Small Business Council of the New York Chamber of Commerce and Industry.

2017 Virtual Worlds Education Conference Schedule

All events take place in Olin Engineering Complex room 118 unless otherwise

Monday, June 5

Start Time	Events and Speakers
9:00 AM	Dr. Annie Becker, Senior Vice President for Research at Florida Tech
9:15 AM	**Keynote Presentation** Mr. Ron Weaver, Technical Design Director at the Florida Interactive Entertainment Academy *Gaming the Educational System*
10:00 AM	Dr. Chang Liu, Associate Professor of Electrical Engineering and Computer Science at Ohio University *Customizable Virtual Chemistry Experiments*
10:45 AM	Break
11:00 AM	Dr. Masataka Okutsu, Assistant Professor of Civil Engineering at The Catholic University of America *Virtual World for Aerospace Engineering Design Course*
11:45 AM	Dr. Cindy Ziker, Senior Researcher at SRI International *Intelligent Virtual Environments for Instruction and Assessment*
12:30 PM	Lunch
1:30 PM	Dr. Kurt Winkelmann, Associate Professor of Chemistry at Florida Tech *Chemistry in Second Life: A Study of Student Learning and Attitudes*
2:15 PM	Dr. Stephanie August, Professor of Electrical Engineering and Computer Science at Loyola Marymount University *The Challenges of Constructing Interactive Digital Aids for Learning*
3:00 PM	Break
3:15 PM	Ms. Maureen Linden, Research Engineer in the Center for Assistive Technology and Environmental Access, Georgia Institute of Technology *BreakThru: Findings and Lessons from using Virtual Worlds to Broaden Participation of Students with Disabilities in STEM Education*
4:00 PM	Dr. Stephanie August, Program Director at the NSF Division of Undergraduate Education *Funding Opportunities at NSF*
4:45 PM	Team Meetings

Tuesday, June 6

Start Time	Events and Speakers
9:00 AM	Announcements
9:15 AM	**Keynote Presentation** Dr. Len Annetta, Taft Distinguished Professor of Science Education at East Carolina University *Getting Serious about Science Education: The Evolution of Serious Educational Games*
10:00 AM	Dr. David Yaron, Professor of Chemistry at Carnegie Mellon University *Using a Virtual Chemistry Laboratory to Engage Students in Authentic Science Practices*
10:45 AM	Break
11:00 AM	Dr. Olinkha Gustafson-Pearce, Researcher and Lecturer in the Department of Design at Brunel University - London *Utilizing Streamed Data to Create Meaningful Virtual Environments to Teach STEM Subjects*
11:45 AM	Mr. Timo Ilomäki, Teacher and Project Coordinator at Jyväskylä Education Consortium, Finland Co-Presenters: Mr. Aki Puustinen, Headmaster and Coordinator at Murrame Senior High School, Finland and Mr. Jukka Sormunen, Headmaster at Kuopio Classical High School, Finland *Virtual Reality in Learning at Four Finnish High Schools*
12:30 PM	Lunch
1:30 PM	**Technology Showcase** Digital Scholarship Lab (DSL), Evans Library
3:00 PM	Break
3:15 PM	Dr. Cynthia M. D'Angelo, Senior Researcher in the Center for Technology in Learning at SRI International *Meta-Analysis of STEM Simulations for Learning*
4:00 PM	Dr. Joe Sanchez, Assistant Professor of Information Science at Queens College - CUNY *Immersive Learning through Roleplay, Self-Expression, and Community Narratives*
4:45 PM	Break
5:00 PM	Discussion

Wednesday, June 7

Start Time	Events and Speakers
9:00 AM	Announcements
9:15 AM	**Keynote Presentation** Mr. Waymon Armstrong, President and CEO of Engineering and Computer Simulations *A Dozen Years in Serious Virtual Worlds: Are We There?*
10:00 AM	Mr. Don Bickley, Virtual Classroom Designer in the Office of Academic Affairs at Prince William Sound College *A First for the Last Frontier*
10:45 AM	Break
11:00 AM	Dr. Erin Saitta, Lecturer in the Department of Chemistry at the University of Central Florida Co-Presenter: Dr. Jackie Chini, Assistant Professor of Physics at the University of Central Florida *Enhancing Professional Development with a Mixed-Reality Classroom Simulator to Prepare Teaching Assistants for Active Learning Instruction*
11:45 AM	Dr. Wendy Keeney-Kennicutt, Presidential Professor for Teaching Excellence (ret.) in the Department of Chemistry at Texas A&M *Integrating Virtual Worlds into the Chemistry Classroom - Can Second Life Improve Spatial Ability*?
12:30 PM	Lunch
1:30 PM	Dr. Richard Lamb, Associate Professor of Learning and Instruction at the University of Buffalo *Cognitive Dynamics: Comparison of Virtual Reality and Hands-on Activities in Science Education via fNIRs*
2:15 PM	Mr. A. Joseph Tamer, Assistant Director of the Center for Education Through eXploration at Arizona State University *Education through eXploration in the Virtual World Environment*
3:00 PM	Break
3:15 PM	Ms. Michele Yeargain, Lecturer and Laboratory Coordinator in the Department of Biology at the University of Central Florida Co-Presenters: Mr. Brian Smith, National Teaching Fellow at the University of Derby, England and Dr. William Prensky, CEO of Chant Newall Development Group (CNDG) *Case-Based Investigations of Faculty and Student Experience in Virtual World Laboratories and Courses*
4:00 PM	Dr. Jonah Firestone, Assistant Professor of Science Education at Washington State University *Virtual Reality Simulation and Writing Complexity: A Pilot Study*
4:45 PM	Break
5:00 PM	Discussion

Thursday, June 8

Start Time	Events and Speakers
9:00 AM	Announcements
9:15 AM	**Keynote Presentation** Dr. William Prensky, CEO of Chant Newall Development Group (CNDG) *Altered States, Altered Perception, and Virtual Worlds* *Where we are, how we got here, and the journey we share together*
10:00 AM	Dr. Reneta D. Lansiquot, Professor of English and Founding Program Director at the New York City College of Technology - CUNY *Interdisciplinary Learning in Virtual Worlds*
10:45 AM	Break
11:00 AM	Mr. William Little, Aerospace Technologist in Software Systems at NASA Kennedy Space Center *The NASA Augmented/Virtual Reality Lab: The State of the Art at KSC*
11:45 AM	Dr. Jungwoo Ryoo, Professor of Information Sciences and Technology at Pennsylvania State University - Altoona College *Immersive Security Education Environment (I-SEE)*
12:30 PM	Lunch
1:30 PM	Ms. Elizabeth Lytle, Director of Education and Product Experience at zSpace *Explorations in zSpace: Investigating Virtual Reality in STEM Classrooms*
2:15 PM	Dr. Stephen Moysey, Associate Professor of Environmental Engineering and Earth Sciences at Clemson University *Immersion Versus Interaction: How Do Platform Choices Impact the Design of VR Learning Experiences in the Geosciences?*
3:00 PM	Break
3:15 PM	Team Presentations
5:00 PM	Closing

Presentation Abstracts

Dr. Len Annetta Taft Distinguished Professor of Science Education at East Carolina University, annettal16@ecu.edu, http://www.lenannetta.com, https://www.linkedin.com/in/len-annetta-972a3a6/, https://twitter.com/drannetta

Co-author: R. Lamb

Getting Serious about Science Education: The Evolution of Serious Educational Games

Today's students learn in fundamentally different ways then have students of the past. They have matured in a connected world where information is on their fingertips and entertainment and learning are beginning to become somewhat symbiotic. The growing use of Web 2.0 (the definition of user-generated websites such as wikis, blogs and such sites as Youtube) and social networking (i.e., Facebook, Twitter, Instagram, Snapchat, etc.) is changing how we must deliver instruction. This session will demonstrate the evolution of Serious Education Games for science and discuss the teaching and learning benefits from my team's research the last 17 years. From early game-based teaching and learning to the mobile technology infusion, this session will discuss both the teaching and the learning theory behind our current work and create a dialogue of how game-based teaching and learning will mature in the coming years.

Mr. Waymon Armstrong, President and CEO of Engineering and Computer Simulations, waymon@ecsorl.com

A Dozen Years in Serious Virtual Worlds: Are We There Yet?

TBA

Dr. Stephanie August, Program Director at the NSF Division of Undergraduate Education, saugust@nsf.gov, http://myweb.lmu.edu/saugust/VESLL

The Challenges of Constructive Interactive Digital Aids for Learning

Wouldn't it be great if we could motivate students to explore new concepts independently, and then come together with classmates and the instructor to apply their newly gained knowledge? Online interactive simulations and experiences that are available 24/7 and utilize multiple modes of communication promise to facilitate this new (or does it return us to the old?) paradigm of learning. Development of an engaging, robust, interactive digital learning aid requires a team of software engineers, content experts, storytellers, and graphic designers to produce more than a simple application. Adding in passive assessment methods and data collection contributes another layer of complexity. In addition, it is difficult to develop a software application that runs on multiple platforms over an extended period of time, resulting in the need to periodically revise code. This discussion will review two efforts in this area, the Virtual Engineering Sciences Learning Lab (VESLL) and Teaching Artificial Intelligence as a Lab Science (TAILS), and summarize the lessons learned from these efforts.

Mr. Don Bickley, Virtual Classroom Designer in the Office of Academic Affairs at Prince William Sound College, https://www.linkedin.com/in/don-bickley-60270546, https://www.facebook.com/openearthproject, http://pwsc.alaska.edu

A First for the Last Frontier

Prince William Sound College was the first campus in Alaska to create a team dedicated to real time, distance based, virtual reality live labs that could be deployed across the state. Seeded with a Title III grant, the project was a collaborative effort between content expert Dr. Julie Fronzuto and designer Don Bickley. This talk will explore the design challenges of constructing science labs across Biology and Chemistry, course design challenges that impact student success, and differences between learning experiences that are creativity-oriented versus real-life oriented. Examples will range from experimental labs in natural selection and genetics, to process-oriented labs such as the examination of chemical and physical changes in a nonphysical, virtual environment. There will be an example of a multi-user, virtual world testing environment for anatomy and physiology, as well as a single-user mine mill operations process simulator. The challenges of designing a suite of labs under the guidance of one instructor and then used as-is by another will also be shared. The presenter has designed and built all examples shown.

Dr. Jackie Chini, Assistant Professor of Physics at the University of Central Florida, jchini@ucf.edu

Presenting with Dr. Erin Saitta.

Dr. Cynthia M. D'Angelo, Senior Researcher in the Center for Technology in Learning at SRI International https://cynthiadangelo.com, https://twitter.com/dapostrophe

Co-Authors: D. Rutstein and C. Harris

Meta-Analysis of STEM Simulations for Learning

This presentation will cover an overview of the process and findings of a systematic review and meta-analysis of the literature on computer simulations for K–12 science, technology, engineering, and mathematics (STEM) learning topics. Important moderating factors related to simulation design, assessment, implementation, and study quality were coded, categorized, and analyzed for all the articles. Computer-based simulations, as defined in this study, needed to be constructed with an underlying model that is based on some real-world behavior or natural/scientific phenomena (such as models of the ecosystem or simulated animal dissections). The important criterion was that the simulation included some interactivity on the part of the user, centered on inputs and outputs of the model. Articles published between 1991 and 2012 were included in the study. Overall, 2,722 abstracts were reviewed, resulting in full-text retrieval of 260 primary research studies potentially suitable for the analysis. Through a thorough review of full-text documents, 201 studies were retained for further analysis. Of these, 60 were determined to be research articles including either an experimental or quasi-experimental design and did not include any incomplete or repeated data sets. For the science achievement outcomes, when computer-based interactive simulations are compared to similar instruction without simulations there was a moderate to strong effect in favor of simulations. Also for the science achievement outcomes, when computer-based interactive simulations were modified to include further enhancements (such as additional learner scaffolding and

certain kinds of feedback), the enhanced simulations had a moderate effect on student learning above the non-enhanced simulations. Most of the assessments used to measure outcomes associated with simulations were paper/pencil based; few took advantage of the affordances of the technology involved in the simulations that were studied.

Dr. Jonah Firestone, Assistant Professor of Science Education at Washington State University, jonah.firestone@tricity.wsu.edu

Co-authors: R. Lamb, S. Yoon and B. Hand

Virtual Reality Simulation and Writing Complexity: A Pilot Study

This preliminary pilot study, utilizing a small convenience sample (N=15) of adult college students, was designed to clarify experimental procedures for the purpose of examining the impact of virtual reality (VR) technology on writing performance. Specifically, this study measured the writing complexity and lexical density of argumentative and summative writing samples provided by adults before or after an immersive VR experience. The primary unit of analysis was a measure of reasoning complexity based on the Complexity of Reasoning Rubrics. Participants were randomly assigned to one of three conditions concerning ecosystems: a VR experience, reading from a general science education chapter, and VR + text. Participants engaged in a writing task before and after the activity based on the Science Writing Heuristic (SWH). Across all three conditions participants with access to the text prior to writing had the lowest complexity of reasoning and lexical density scores on argumentative and summative writing samples, while participants who experienced VR and had access to the book, had the highest scores on both writing samples. The most interesting finding of this small study was that VR by itself was not enough to produce the highest scores on reasoning complexity and lexical density measures.

Dr. Olinkha Gustafson-Pearce Researcher and Lecturer in the Department of Design at Brunel University – London, https://www.linkedin.com/in/olinkha-gustafson-pearce-98323513

Utilizing Streamed Data to Create Meaningful Virtual Environments to Teach STEM Subjects

This presentation focuses on using virtual world technology, visualization methods and design to create an environment, which uses online (IoT) data streams to give inworld 'objects' form and function. The presentation will discuss and demonstrate a created environment in the Metropolis Grid, which shows how streamed data from the United States Geological Survey (USGS) Earthquake Hazards Program, can be used to create a 'meaningful' environment for a variety of uses, including teaching STEM subjects. In the created virtual world, real time streamed data from the USGS was utilized by the virtual world and represented by a variety of designed artifacts. The main 'area' had a large (10-meter sphere) which was a 'model' of the Earth. This Earthglobe had many functions; objects were 'scripted' to 'appear' when earthquakes events happened. These artifacts had a number of 'states'. They showed location on the Earthglobe by physical presence; appearing at the location of the earthquake, colour defined Magnitude (M on the Richter scale) from red = M7+, green = M4 to M7 and yellow = M2.5 to M4. Depth was defined by a series of 'circles' where if the earthquake was below 80km then the circles appeared slow moving, to fast moving 'spiral' effects which meant that the earthquake was close to the surface. The closer to the Earth's surface of the earthquake, the faster the circles appeared to move. When the earthquake first occurs the colours are bright;

as time passes the colour slowly fades (using opacity) over a three-day period. Since this data was updated every 3 minutes, real time information was available to the viewer. Therefore, the user could, at a glance, see that a representation which appeared over Tokyo showing bright red, fast moving circles would be a major earthquake that had just occurred, close to the surface and a potential 'disaster' situation. There were several additions to the data. If the user wanted further information about the earthquake they could click on the artifact and a text description of the event would appear, they could also click on this description and go to the web page from the USGS, where considerable more detailed information was available. Also, a representation of the moon and night/day on the planet showed the Terminator zone and light/dark on the Earth in real time. Additional areas were also created. These include an exhibition which showed various aspects related to earthquakes including a 'what to do in an earthquake' with an interactive Q&A panel that tested users' knowledge about how to stay safe in the event of an earthquake. There was also a 'discussion' area with seating where avatars could sit and chat. 'Voice' was enabled in the environment, which enabled the engagers to discuss topics in real time. Virtual world environments which use streamed data of this kind can be used for teaching all STEM subjects and can be individually created dependent on the requirements. In this example, the USGS data visualization can be used to teach Physical Science, Geological Science, Technology - more advanced students can learn to script and create similar 'responsive/reactive' objects, Engineering – students can learn about engineering challenges within earthquake zones and Math – building, coding, and scripting. There is also an element of 'Art' that can be included in the process; to create 'meaningful' environment**s**, design would certainly be needed, therefore the STEAM (Science, Technology, Engineering, Art, Math) acronym may be used. The Earthglobe is designed to be 'understandable' to all ages and has elements which, if developed further, could be useful to more specialist areas. For example, first responders to an emergency caused by a large earthquake, can view this and other streamed data (Facebook images of the area before the earthquake) in the virtual world, and because a large part of the data is visual, could be useful for people for whom English is not their first language**.** In these 5D (3D + time + sound) worlds, the potential to create virtual worlds in which the user can fly through the data, skim the surface or deep dive into currents of connected information, fits well with the 'habits' of the younger generations, and opens myriad possibilities of teaching and learning in completely different, new and innovative ways.

Mr. Timo Ilomäki, Teacher and Project Coordinator at Jyväskylä Education Consortium, Finland, https://www.instagram.com/fineduvr, https://twitter.com/ilotimo?lang=en

Virtual Reality in Learning at Four Finnish High Schools

Virtual reality in learning projects is funded by the Finnish National Board of Education. We want to share our experiences testing and using virtual reality in education context. We have HTCvive systems in our schools, also Samsung Gear VRs, and Google Cardboards. In the presentation, we will show with videos how to market our schools with 360° videos and drones. Presentation will be very visual and practical with lots of photos and videos. Virtual reality is a hot topic now at Finnish education. We have a U.S. partner (Foundry10) and we are sharing experiences with them.

Dr. Wendy Keeney-Kennicutt, Presidential Professor for Teaching Excellence (ret.) in the Department of Chemistry at Texas A&M

Co-author: Z. Merchant

Integrating Virtual Worlds into the Chemistry Classroom - Can Second Life Improve Spatial Ability?

The 3D environments of virtual worlds like Second Life (SL) have much to offer a general chemistry classroom instructor, especially when teaching chemistry concepts about the 3D nature of molecules. Students can benefit from a variety of synchronous and asynchronous activities within a virtual world, including office hours, videos, simulations, games, quizzes and interactions with virtual chemical species. We conducted an extensive mixed methods study comparing test results of students who finished three activities in SL to the results of a control group who did the same activities on paper. These activities progressed in difficulty to develop 3D spatial awareness in chemistry students. Findings showed subtle but significant differences in increased student ability by the SL group for interpreting routine 2D presentations of 3D chemical structures using solid lines, dashed lines and wedges. Although the experimental group attitudes toward SL were split on whether SL was a good idea for a chemistry class, the potential benefit of SL in chemistry classrooms was demonstrated. The results of a smaller study of how students accepted a Second Life Molecule Building Kit will also be shared.

Dr. Richard Lamb, Associate Professor of Learning and Instruction at the University of Buffalo, rllamb@buffalo.edu, https://twitter.com/RLamb9137, https://www.facebook.com/UBNCSL, https://www.linkedin.com/in/richard-lamb-51817034

Co-authors: L. Annetta and R. E. Lamb

Cognitive Dynamics: Comparison of Virtual Reality and Hands on Activities in Science Education via fNIRs

The purpose of this study was to investigate differences in the level of hemodynamic response as it relates to four different approaches to teaching the processes of DNA replication in life science. The first approach used a lecture based learning approaches. Lectures were delivered in a video-based format in which students took notes. The other approaches used an immersive Serious Educational Game and a virtual reality environment in which students completed a class on DNA replication. In the fourth approach, hands-on activity, students engaged in a DNA replication similar to that found in the Serious Education Game and virtual reality condition but did so with manipulatives. Functional near-infrared spectroscopy (fNIRs) was used in this study to examine hemodynamic localization and relative cognitive dynamics associated with each condition. In addition to examination of cognitive demand and dynamics via hemodynamic activation, learning gains were triangulated via correlation to content-based pretest and posttest gain scores. Results suggest that the group using the virtual reality and Serious Educational Game had a significantly higher score increase on the posttest and produced greater activation in memory and critical thinking.

Dr. Reneta D. Lansiquot, Professor of English and Founding Program Director at the New York City College of Technology – CUNY, rlansiquot@citytech.cuny.edu, http://www.citytech.cuny.edu/faculty/RLansiquot

Interdisciplinary Learning in Virtual Worlds

Interdisciplinary learning allows students to purposefully connect and integrate knowledge, while virtual worlds facilitate students' creation and exploration of interdisciplinary concepts. Drawing from the presenter's pedagogical use of Second Life, a popular 3D virtual world, this presentation will illustrate how simulations can support interdisciplinary studies, including integrative, collaborative and place-based learning. Examples will be provided from the presenter's participation in pedagogical projects applying this approach to middle, high school and undergraduate courses, which covered a wide range of subjects from language learning to the geosciences and technical writing. The presentation will also explore the new roles that both educators and learners must assume in the process of using virtual worlds in an interdisciplinary context while also discussing various successful approaches for creating active learning spaces that can successfully promote interdisciplinary studies.

Ms. Maureen Linden, Research Engineer in the Center for Assistive Technology and Environmental Access, Georgia Institute of Technology, maureen.linden@design.gatech.edu, http://www.georgiabreakthru.org/, https://www.youtube.com/user/BreakThruGSAA, http://www.catea.gatech.edu/

Co-authors: N.W. Moon, R. Todd, N. Gregg, G. Wolfe, and M. Talley

BreakThru: Findings and Lessons from using Virtual Worlds to Broaden Participation of Students with Disabilities in STEM Education

BreakThru is a project of the NSF-funded Georgia STEM Accessibility Alliance (GSAA) to broaden the participation of students with disabilities in science, technology, engineering, and mathematics (STEM) education. BreakThru has used Second Life to provide virtual mentoring for secondary and postsecondary students with disabilities at three participating colleges and universities and in three high school districts. Between 2011 and 2015, BreakThru enrolled 98 postsecondary and 75 secondary students, most of whom were retained within the program. Second Life was used as a platform for providing mentoring, transition assistance, academic support, and career guidance. This presentation will focus on our development of BreakThru Island in Second Life and how it was expanded and revised to better reflect the needs and expectations of our participants. We also will discuss some of the accessibility and policy challenges in using virtual worlds to support students with disabilities, including the need to adapt to diverse communication preferences and address concerns of safety and security. We also will present findings from research about the potential of virtual worlds and mentorship programs within those environments to support retention and persistence in STEM education.

Mr. William Little, Aerospace Technologist in Software Systems at NASA Kennedy Space Center, william.l.little@nasa.gov

The NASA Augmented/Virtual Reality Lab: The State of the Art at KSC

The NASA Kennedy Space Center Augmented/Virtual Reality Lab is dedicated to the study of new, commercially available augmented and virtual reality devices with the goal of integrating those devices, or their future versions, into NASA's operational tool set. Investigations into devices such as the Microsoft Kinect and Hololens, the Oculus Rift, the HTC Vive, and the Leap Motion have yielded observations on the state of the art, the strengths and weaknesses of the current technologies, and a glimpse into the future of human computer interaction. Begun as the result of a 2012 KSC Innovation Expo Kickstart award, the AVR Lab has grown into a testbed for concepts that push the boundaries of how the virtual world and the physical world interact with one another, sometimes blurring the lines between what is virtual and what is physical. Proof of concept projects such as Virtual Control Panel, Virtual Tablet, Orion Virtual Cockpit, and Immersive Virtual Telepresence are stepping stones in this latest phase of the computer revolution, a phase which promises to forever change how we see the world.

Dr. Chang Liu, Associate Professor of Electrical Engineering and Computer Science at Ohio University, liuc@ohio.edu

Co-author: Y. Zhong

Customizable Virtual Chemistry Experiments

Chemistry teachers typically do not have the necessary expertise in 3D modeling and coding to create their own virtual chemistry experiments. To address this problem, we developed a prototype customizable chemistry experiment that enabled non-3D-designers to create individualized chemistry experiments. Our evaluation showed that 28 out of 32 participants of the usability studies were able to build a 3D virtual chemistry experiment within one hour. Additionally, the solution was considered easy-to-learn by 80% participants and easy-to-use by 52% participants.

Ms. Elizabeth Lytle, Director of Education and Product Experience at zSpace, elytle@zspace.com

Co-author: C. Ziker

Explorations in zSpace: Investigating Virtual Reality in STEM Classrooms

Virtual reality (VR) and augmented reality (AR) are transforming the teaching and learning of science, technology, engineering, and mathematics (STEM), by engaging students in the use of innovative tools such as zSpace. While research is limited regarding the effects of VR on student achievement, qualitative evidence from teachers using zSpace reveal reports of high levels of student engagement, collaboration, and increased interest in STEM. This hands-on technology presentation will engage participants in experiencing zSpace, and will include case studies developed through a research partnership with SRI International that target the experiences of teachers who have implemented zSpace Learning Labs in science classrooms, as well as afterschool STEM programs. Unlike other virtual reality solutions, such as head-mounted displays, zSpace enables interaction and group collaboration. Implementation strategies, challenges and lessons learned from experienced educators will be presented. zSpace combines elements

of VR and AR, in an all-in-one computer, to create learning experiences that are immersive and interactive for students across multiple grade levels and subjects. The zSpace station is shared by two students who collaborate on lessons that mix the real world with the virtual, such as exploring the inner workings of the human heart or designing and building circuit boards. In addition to dissecting and rotating objects, students can design and print 3D models using compatible applications and 3D printers. In collaboration with zSpace, SRI is creating a research agenda designed investigate the effectiveness of VR/AR based instruction in the classroom.

Dr. Stephen Moysey, Associate Professor of Environmental Engineering and Earth Sciences at Clemson University, smoysey@clemson.edu

Co-authors: M. Boyer, V. Sellers, K. Lazar, and C. Mobley

Immersion Versus Interaction: How Do Platform Choices Impact the Design of VR Learning Experiences in the Geosciences?

Fully immersive virtual reality environments provide an exciting platform for learning about the world around us. Our Virtual Reality Field Experiences (VRFE) project aims to take students through a fully immersive gaming experience to explore the geology of the Grand Canyon in a search for resources. Our learning goals target improving student understanding and application of basic geologic concepts within the context of a real-world field setting. Development of a full-scale, truly immersive VR experience like VRFE, however, is a challenge that requires a substantial investment of resources. Not only is the need for extensive programming a potential obstacle, but the limitations of today's mobile device hardware may also necessitate compromises between performance and student accessibility. As a result, we are also exploring the use of 360° imagery as a readily accessible alternative for the development of VR experiences. A clear benefit of this imagery is the potential to better represent real-world settings via photographs or videos, but this approach comes at the cost of denying students the ability to explore a true virtual environment. Even though the use of 360° imagery does not allow for the same range of interactivity provided by a true, fully immersive VR environment, some degree of interaction can be provided through web-based link editors such as ThingLink. By integrating content, embedded assessments, and multiple 360° images, it is possible to create an experience that allows students to journey through a set of learning objectives in a similar way as allowed by a more sophisticated tool like VRFE. Image editing tools can also allow anyone – including K-16 students – to create an interactive VR experience without any specialized training. As a result, utilization of 360° imagery also expands the potential for students to use VR as a platform for content creation and not just as a means of content consumption. While the choice of platform will clearly impact the level of immersion and interaction that can be achieved within a VR experience, we suggest that either type of platform can be used to create an effective and affective learning experience for students if well designed.

Dr. Masataka Okutsu, Assistant Professor of Civil Engineering at The Catholic University of America, okutsu@cua.edu, http://engineering.cua.edu/faculty/profiles/Okutsu.cfm

Virtual World for Aerospace Engineering Design Course

Technologies of virtual worlds—digitally-rendered 3D environments in which multiple users could interact

to each other using their avatars—continue to get better, cheaper, and more widely available. Could virtual worlds be used to teach university-level courses? Although educational use of virtual environments has been studied in the past two decades, there are very few experimental studies that could validate the efficacy of virtual world to teach a semester-long course. Our goal was to address this gap in the literature. We designed one of the first experiments to measure learning outcomes (rather than subjective affective states) against a control group. To achieve this goal, we developed our own virtual world environment and used it to teach a semester-long engineering design course for university credits. A total of 135 second-year aerospace engineering students was divided into two groups: the real-world group attending lectures, physically, in a classroom on campus and the virtual-world group attending lectures, remotely, in the virtual world. The virtual-world group achieved the performance benchmark, suggesting the virtual worlds' untapped potential as a feasible teaching platform. This presentation will also discuss the lessons learned as well as new possibilities that were found through our investigation on virtual-world education.

Dr. William Prensky, CEO of Chant Newall Development Group (CNDG) bill@cndg.info, www.cndg.info

Altered States, Altered Perception, and Virtual Worlds: Where we are, how we got here, and the journey we share together

Bill Prensky has been working at the crossover of psychology, education and healthcare for five decades. In 2006, he got together with a small group of likeminded emergent technology enthusiasts to found CNDG, which over the past decade has specialized in creating innovative and immersive virtual learning environments.

In this talk, Bill will reflect upon the reasons why virtual worlds are so successful as a medium for education. He will propose ways of deepening the engagement of faculty, courseware creators and students with virtual worlds in order to create more intimate platforms for inquiry and education, and will look ahead to the future of Virtual Worlds for Learning and Teaching.

Also Co-presenting with Ms. Michele Yeargain.

Mr. Aki Puustinen, Headmaster and Coordinator at Murrame Senior High School, Finland, aki.puustinen@edu.muurame.fi, http://fineduvr.fi/, http://apuustin-leadership.blogspot.fi/, https://peda.net/muurame/lukio

Presenting with Mr. Timo Ilomäki.

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Immersive Security Education Environment (I-SEE)

Institutions of higher education, government agencies, and private organizations have been making sustained efforts to teach information security skills more efficiently. In these efforts to improve security education, the dominant pedagogical approach has been to use security exercises in a lab setting. However,

this approach might not deliver effective learning experiences for two reasons:

Narrow focus on technology: Current laboratory exercises focus on security attacks and technical solutions, yet security management must also account for operations and people. Failing to address any of them leaves systems vulnerable, so security education must equally emphasize technical security measures and safe online behaviors.

Decontextualized learning: Most existing security labs teach abstract concepts that aren't situated in real-life contexts, such as simple message-sending scenarios between people, to teach security protocols and encryption methods. However, a student who learns security concepts solely in a decontextualized setting might not be able to apply the necessary skills when facing real-life security threats.

Addressing these two shortcomings requires security education approaches built around real-world scenarios that actively engage students. Just as a problem-based learning approach fosters a collaborative discovery process through solving authentic, real-world problems, security education should be anchored in real-life problems that help develop technical security skills and promote safe online behaviors.

Discovery learning is a paradigm that emphasizes students as active participants in the learning process as they interact with the environment and other students. Sophisticated virtual environments that use 3D simulations are well-suited for such learning because they provide vicarious experiences and more realistic contexts than other technologies do. They not only make learning more enjoyable, but they also enable students with little knowledge about a problem domain to develop a greater understanding of it, better problem-solving skills, and higher-order thinking about issues and rationales to support their solutions.

A 3D virtual immersive world that simulates everyday real-world activities, can serve as an ideal platform for incorporating both realistic scenarios and discovery learning into security education. This talk shares our experience in developing a scenario-based security education system using a 3D Virtual Learning Environment (VLE) and implementing it in introductory courses on information security at Pennsylvania State University.

Dr. Erin Saitta, Lecturer in the Department of Chemistry at the University of Central Florida, erin.saitta@ucf.edu

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Enhancing Professional Development with a Mixed-Reality Classroom Simulator to Prepare Teaching Assistants for Active Learning Instruction

This presentation will discuss the use of a mixed-reality classroom simulator to help teaching assistants (including graduate teaching assistants and undergraduate learning assistants) develop the skills needed to facilitate instruction in active learning environments. In response to national calls to improve undergraduate STEM education, many departments have increased their use of active learning strategies in a range of courses including those involving teaching assistants. We will describe how TeachLivE, a classroom simulator which creates an immersive environment by combining real and virtual worlds, was incorporated into physics and mathematics teaching assistant professional development. Data involving student performance connects skills GTAs can practice in the simulator to challenges they face in the classroom.

Dr. Joe Sanchez, Assistant Professor of Information Science at Queens College – CUNY, Jose.sanchez2@qc.cuny.edu, http://drjoesanchez.com, https://www.linkedin.com/in/joesanchezphd/, https://twitter.com/Dr_JoeSan

Immersive Learning through Roleplay, Self-Expression, and Community Narratives

This paper argues that learning activities within Virtual Worlds should be designed as nonlinear, open-ended community narratives. These spaces, where students are encouraged to perform their identity, promote positive student interactions, and lower the technical barriers often reported with first time users of virtual environments. The goal of this paper is to 1) identify both the low level and high-level communication affordances of MUVE when used as a learning platform, 2) Analyze two particular cases, a college level World Literature course and an Information Studies undergraduate course, and 3) discuss the sociotechnical systems approach as a way to design virtual world learning activities.

Mr. Brian Smith, National Teaching Fellow at the University of Derby, England. mr@brian-smith.info

Presenting with Ms. Michele Yeargain.

Mr. Jukka Sormunen, Headmaster at Kuopio Classical High School, Finland, jukka.sormunen@kuopio.fi, https://klassikka.onedu.fi/web/international/, http://fineduvr.fi/briefly-in-english-fineduvr/

Presenting with Mr. Timo Ilomäki.

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Education Through eXploration in the Virtual World Environment

The Center for Education Through eXploration at Arizona State University has created more than two dozen science-focused virtual field trips, most of which are available at vft.asu.edu. From this foundation, we have learned much about the immersive environment and now have VFTs that incorporate interactive lessons, videos, animations, data collection and graphing exercises. As we have explored different formats we have discovered pathways for translating these digitally immersive environments into meaningful learning experiences across the spectrum. At the high end, we have adapted an introductory level college biology lesson into a Virtual Reality experience for the HTC Vive. On the opposite end of the spectrum our development team has adapted our exploratory format to work on hand-held devices, as well as separately within the Google Cardboard and Google Expeditions platforms. Energized by this challenge, our team pushed the boundary further, creating pathways for these immersive VFTs to be delivered in low and no-bandwidth environments, using a Solar SPELL device for even the most remote locations. Additionally, this work prompted us explore further Unity development and create immersive game-based lessons using real scientific data and images, all of which are aligned to national scientific standards. Built into this immersive star field of "Where Are The Small Worlds?" are stealth assessments, logical models, and a system to track student behavior. Bring your laptop or smartphone so that you can explore with us during this interactive presentation and discussion.

Mr. Ron Weaver, Technical Design Director at the Florida Interactive Entertainment Academy, ron.weaver@ucf.edu, www.fiea.ucf.edu

Gaming the Educational System

If games in the classroom means students staring at screens in computer labs then we are only scratching the surface. Successful video games and tabletop games showcase an abundance of mechanics rarely applied to education. Mainstream titles are also crafting innovative ways to edify players. We will study exemplary gameplay, forge connections to learning outcomes, and project a future where students don't equate educational games with Brussels sprouts.

Dr. Kurt Winkelmann, Associate Professor of Chemistry at Florida Tech, kwinkel@fit.edu

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Chemistry in Second Life: A Study of Student Learning and Attitudes

Virtual worlds are a potential medium for teaching college-level chemistry laboratory courses. In order to determine the feasibility of conducting chemistry experiments in such an environment, undergraduate students performed two experiments in the immersive virtual world of Second Life (SL) as part of their regular General Chemistry 2 laboratory course for multiple semesters. The experiments' development and implementation are presented with feedback from students and graduate teaching assistants. Students successfully completed the experiments and showed learning gains similar to students performing real world experiments, as shown by pre/post lab quizzes, lab reports, and a laboratory practicum. Student participants held positive views of their experience in the SL chemistry laboratory. Teaching assistants provided an important perspective about using the virtual world for laboratory instruction. Overall, results of this study suggest that virtual worlds can be effective for teaching chemistry experiments.

These results are relevant to chemical education in a variety of ways. For on-campus courses, activities in virtual worlds can provide a means to address shortages in budgets and laboratory space. Existing online chemistry courses often lack a high-quality laboratory experience. Virtual worlds enable students to conduct interesting, realistic experiments which may be impractical to perform in a real-world setting. Students can work independently or with lab partners, under the supervision of an instructor or autonomously.

Dr. David Yaron, Professor of Chemistry at Carnegie Mellon University, yaron@cmu.edu, www.chemcollective.org

Using a Virtual Chemistry Laboratory to Engage Students in Authentic Science Practices

Introductory chemistry has evolved a set of canonical problem-solving activities that are the focus of current instruction and assessment. However, a growing body of evidence indicates that students can succeed at these canonical activities, yet fail to gain an understanding of the "big ideas" of the domain. Our guiding hypothesis is that more robust learning can be achieved through inquiry activities that couple domain content to "science practices" that reflect how chemists solve real world problems. Virtual laboratories are well positioned to engage students in two science practices that are especially relevant to chemistry: the design of investigations and the interpretation of scientific data. Our virtual lab (chemcollective.org) allows traditional homework to be routinely coupled to online activities involving experimental design and interpretation. Our results suggest that the benefits of such activities go beyond illustrating how chemistry

is used in practice. In addition, by requiring students to select and generate the data needed to solve a problem, virtual lab activities help students move beyond shallow problem-solving strategies. In more traditional problem-solving activities, means-ends analysis and other shallow strategies interfere with learning by allowing students to succeed at a task without developing the conceptual understanding the task was intended to support. In virtual lab activities, students must think more deeply about the chemical system, the types of data that can be gathered, and the utility of that data. Virtual laboratories also allow the environment to be optimized to promote conceptual learning. For example, we can allow students to peer into a chemical solution and see its contents. This provides a scaffold that is not possible in the physical laboratory. The construction of virtual worlds allows instructional designers to fundamentally rethink the goals of instruction and to optimize the pathways through which students may achieve those goals.

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Case-Based Investigations of Faculty and Student Experience in Virtual World Laboratories and Courses

In 2012, the UCF Department of Biology sought to change our core curriculum to include (and require) more upper division (3000 and 4000 level) laboratories for our majors. In order to accomplish this goal, we needed to reallocate many of our Graduate Teaching Assistants (GTAs) from Biology I into these new upper division labs. At the time, between 66-75% of our GTA pool was required to teach the laboratories associated with this extremely large (1500 students per semester) course. To this end, we began exploring the option of online/virtual laboratories for Biology I. The department wanted to maintain the feel of a face-to-face lab with the ability for the students to interact one-on-one with each other and with the GTAs. Although isolated single user sign-on online laboratories could not meet this requirement, a shared multiuser interactive virtual 3D immersive simulation laboratory could. After conducting experiments over several semesters with online labs and virtual labs, we quickly determined that the virtual labs developed by CNDG, in partnership with Pearson Learning Solutions, met and even surpassed our expectations. We are now able to provide an experience that feels like a face-to-face laboratory in terms of student-student and student-GTA interaction, while also giving our students a unique experience that would be impossible in a traditional face-to-face lab. For instance, four of our laboratories are conducted inside "The Giant Cell" which students can walk through to understand the process of Cellular Respiration, Mitosis and Meiosis, DNA Synthesis, Transcription and Translation. In terms of learning outcomes, we found the students to be more engaged in this unique learning experience which resulted in fewer absences from the laboratory. We also had "lightbulb" moments in lecture with students grasping biological concepts introduced in lecture much quicker than they had in prior semesters. These positive results encouraged us to move entirely to this virtual laboratory platform for Biology 1 in the Spring 2015 semester. This Spring 2017 semester marks our third year using this virtual platform with plans to continue unabated into the future.

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Intelligent Virtual Environments for Instruction and Assessment

Intelligent virtual environments (VEs) hold promise for improving learner-directed instruction and

assessment. As part of DARPA's program, "Manufacturing Experimentation and Outreach Two (MENTOR2)" program, SRI International implemented the 'Simulating Manufacturing and Prototyping with Learning Environments' (SiMPLE) project, which leverages VEs to accelerate learning. SiMPLE uses a scalable massively-open online course (MOOC) interface and a 3D robotics simulation software package called Gazeebo, to support rapid prototyping and iterative model enhancements. SiMPLE promotes understanding of the modeling tools that are essential for a diverse range of higher-order applied fields, such as engineering. Learning goals include developing proficiency in using 3D simulation with other technologies (e.g. 3D printers, laser cutters, and robot kits), and troubleshooting complex systems. Course materials include multiple representations such as: a 3D world view to enable visualization of model interactions; a schematic view for comparing disparate systems; a model editor view of the kinematics of the model; and a physical representation created with a robot kit. A graphing utility tool is provided to enhance learners' diagnosis of design flaws. Embedded formative assessments provide auto-generated feedback. A pilot study with adults found evidence of the advancement of learning goals.