THE WINSTON CHURCHILL MEMORIAL TRUST OF AUSTRALIA

Report by - BEN NEWSOME - 2013 Churchill Fellow

The Northern Districts Education Centre (Sydney) Churchill Fellowship to investigate best practice in science education via video conferencing - Canada, USA

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INTRODUCTION

Distance education has been an integral part of the teaching landscape due to the vast distances and isolation of communities in regional and remote Australia. Teaching over these distances a century ago required education to be completed via correspondence, whereby lessons were exchanged using the postal system. In many of these cases it would take weeks or even months to make a round trip between educator and student. Strong educational outcomes were limited and the future for secondary or tertiary education was bleak without the reliance of boarding schools. Capitalising on the advent of 2-way radio and subsequent establishment of communication networks by the Royal Flying Doctor Service, distance educators began operating with students via ‘Schools of the Air’, allowing for real time communications between remote sites. Teaching via radio communications was the principle tool for distance education until video conferencing and internet technology became available in 1990’s. Initially run over ISDN at great cost, video conferencing became more accessible once designed to run via internet protocol, opening up the possibility for the 2007 large scale rollout of the Connected Classrooms Program throughout NSW public schools with other States also establishing their own networks.

The introduction of H.323 video conferencing into schools radically changed the ability of teachers to improve learning outcomes and reduce social disadvantage by distance. Students were now able to tour museums, speak with renowned experts, participate in collaborative learning or communicate with students across the globe in every key learning area from their own classroom. All this at a fraction of the cost of the buses and accommodation and without the inherent disruption to school timetables or onerous risk assessments needed for excursions. Seeing the advantages of virtual excursions, the NSW Distance and Rural Technologies actively worked with cultural institutions to establish best practices in educational video conferencing and formed a booking hub and bridging system for schools to participate in virtual excursions that suit their curriculum needs. This has been followed by the Victorian Virtual Learning Project, the TtEDSC Project, CENet eLearning, See Share Shape calendar and more.

Technological innovations that satisfy needs drive change. Many schools across Australia now regularly use H.323 video conferencing and with the new arrival of cloud-based non-H.323 solutions Australian schools and any entity connected to the internet can access educational content from around the globe and form real relationships between isolated communities using desktop computers or smart devices. With the future establishment of the National Broadband Network every Australian in every locality has the opportunity to access ubiquitous education and participate as a global citizen, regardless of its final configuration and rollout schedule.

I formed Fizzics Education in 2004 to bring informal science education to all students everywhere, touring remote and regional Australia in a Ute many times to bring equitable access of resources to communities. On suggestion from several Country Area Program schools we became the first private Australian entity to run virtual excursions in 2010. Seeing the need for establishment of best practices between video conference content providers we began working with a variety of museums and cultural institutions in NSW to form a monthly working group in 2011. This has since morphed into Virtual Excursions Australia (VEA), bringing together over 40 content providers and booking systems from across Australia and was formally launched by the Hon. Senator Kate Lundy at ITEC2013. The charter of VEA is to expand digital literacy and the use of collaborative technologies throughout Australia and is now rapidly bringing together world class education providers for schools, libraries, retirement homes and more to access. As such in 2013 VEA had positively impacted over 100,000 students and will reach more by the end of 2014.

In May and June 2014 I undertook a study of science centres, museums, zoos, aquariums and school districts in North America to investigate the best practices available in science education via video conference. The fellowship looked at innovative ways video conference systems, tablets, desktop systems, smart phones and more are being used to teach science. The findings are appropriate for all; not only in formal science education or in distance learning but also those involved in improving aged care outcomes, community hub access, University teaching, hospital schools, juvenile justice sites and others interested in improving the quality of education in Australia.

This study would not have been possible without the generous sponsorship of the Northern Districts Education Centre (Sydney) as well as the fantastic support from the Winston Churchill Memorial Trust to whom both I will always be indebted. I greatly appreciate the efforts of all the educators, managers, teachers and directors who afforded me their time to contribute expertise towards this report for the Australian community. Without these talented and resourceful people as well the constant support from my wife, family and the education team at Fizzics Education the study tour would not have been possible. I encourage you to share this report widely!

Winston Churchill Fellowship Report

Ben Newsome
EXECUTIVE SUMMARY

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A seven week Churchill Fellowship tour was conducted to investigate the best practices available in science education via video conferencing in over 16 science centres, museums, zoos, aquariums and school districts across North America. Many talented distance educators were met who graciously shared their insights and techniques on how to produce outstanding science & technology video conferencing lessons for remote learners in schools, libraries, retirement homes, juvenile justice centres and more. A few highlights were:

- Learning how to incorporate animated games & live dissections into marine biology video conferences at the Aquarium of the Pacific in Los Angeles.
- Visiting Alaska to learn techniques in teaching ecology at the Alaska SeaLife Center and Alaska Zoo.
- A trip into the Canadian badlands to learn how palaeontology is taught at the Royal Tyrrell Museum.
- Speaking with the talented team at the Centre for Interactive Learning & Collaboration in Indianapolis & the Central New York Regional Information Center on video conferencing installation and best practices.
- Being immersed in the simulated learning environments at Rochester Challenger Learning Center and the Bathysphere Underwater Biological Laboratory plus spending time with the talented distance educators at the Cleveland Museum of Natural History, the Cleveland Museum of Art, the International Spy Museum, Nina Mason Pulliam Ecolab and the Intrepid Sea, Air & Space Complex.
- Touring the Washington DC galleries & museums offered by the Smithsonian Institution and more.
- Discovering robotic video conferencing technologies being used at the New York Hall of Science.
- Participating in best practice discussions with many video conferencing content providers at a meeting at the Center for Puppetry Arts and then meeting leaders of the educational video conferencing community at the International Society for Technology for Education conference in Atlanta.

The major lessons from this fellowship for the Australian educational video conferencing community are:

- Professional development in collaborative technologies needs to be ongoing in the school system and should be embedded into pre-service teaching courses at Universities. Video conferencing should be incorporated into all mainstream teaching & learning sequences to enrich the K – 12 curriculum. This is critical as significant investment has already been made to install H.323 systems in over 3000 schools.
- Funding for establishment of mobile H.323 systems into all schools, libraries, hospitals, retirement homes & juvenile justice sites needs to occur and should be ongoing. Additionally funding should be allocated yearly for these public sites to engage in STEM video conference experiences. Internet bandwidth must be increased in schools & libraries to allow high definition video conferencing to take place as soon as possible with a minimum external speed of 1152 kbps per site allocated specifically for H.323 conferencing systems.
- The various booking systems in Australia should be unified into one federal platform for any site to find video conference educational experiences. It should be funded, publicly accessible, offer an MCU bridge, embrace cloud based web conferencing solutions that link to H.323 systems, convert to local time zones, include public evaluations & offer events both through a calendar as well as by request to cater for timetables. Connections should be directly between content provider & site unless bridging for multiple sites is needed.
- Funding for Australian content providers running video conference classes be allocated for those surpassing a consistent audience-reviewed performance evaluation benchmark agreed to by all Australian providers.
- Collaboration across content providers should occur between all sites to increase best teaching practices.
- STEM video conferencing lessons must be interactive and hands-on to be relevant to a learner of any age.
- Museums & cultural institutions consider installing roving video conference robots to bring remote learners access to their galleries & learning spaces.

This Winston Churchill report and its findings will be disseminated via:

- State and Federal Education Departments and Ministries as well as University Faculties of Education.
- Virtual Excursions Australia network of content providers, booking systems and VC experts.
- Through Principal, science teacher and ICT teaching associations plus professional conferences.
- Through the network of schools already engaging with Fizzics Education for STEM outreach delivery.
PROGRAMME

Initial research using advice from key educational video conferencing experts and searching the Centre for Interactive Learning & Collaboration database for Pinnacle Award winners identified a number of education providers in USA and Canada known to use outstanding methods in instructional practice. Providers not able to be visited on-site were met at the 2014 International Society for Technology in Education Conference in Atlanta, Georgia. There are over 230 content providers in North America let alone schools, sadly I couldn’t see them all!

May 23 - Day visit to Aquarium of the Pacific in Long Beach, California.
- Meeting with Ms Alicia Archer, Education Manager.
- Meeting with Mr David Bader, Director of Education.

May 26 & 27 – Two day visit to Royal Tyrrell Museum of Palaeontology in Drumheller, Alberta
- Meeting with Ms Megan McLauchlin, Senior Distance Learning Educator.
- Meeting with Ms Jillian Steele, Distance Learning Educator.
- Meeting with Mr Jason Martin, Director - Operations & Finance.

May 28 – One day visit to GCI School Access in Anchorage, Alaska
- Meeting with Ms Pam Lloyd, Senior Director, GCI School Access & Chair, Centre for Interactive Learning & Collaboration.

May 29 – One day visit to Alaska Zoo in Anchorage, Alaska
- Meeting with Ms Stephanie Hartman, Director of Education.

May 30 – One day visit to Alaska SeaLife Center in Seward, Alaska
- Meeting with Mr Darin Trobaugh, Education Specialist.

June 4 – One day visit to Center for Interactive Learning & Collaboration in Indianapolis, Indiana.
- Meeting with Ms Janet Zanetis, Chief Executive Officer.
- Meeting with Ms Julia Shildmyer-Heighway, Director of Content Services.
- Meeting with Ms Tonia Carriger, Director of Business Development.
- Virtual Meeting with Mr Jack Matheson Program Associate - Distance Learning at History Live.

June 5 – Day visit to Children’s Museum Indianapolis

June 6 – One day visit to Nina Mason Pulliam EcoLab at Marian University, Indianapolis
- Meeting with Ms Janice Hicks Slaughter, Director of K-12 Programming and Outreach.

June 8 – Day visit to Great Lakes Science Center

June 9 – One day visit to Cleveland Museum of Natural History in Cleveland, Ohio.
- Meeting with Ms Lee D. Gambol, Distance Learning Coordinator.
- Virtual Meeting with Ms. Michel Carlisle Director of Distance Education of East Central Ohio ESA.

June 10 – One day visit to Cleveland Museum of Art in Cleveland, Ohio
- Meeting with Ms. Dale Hilton, Director, Teaching and Learning.
- Meeting with Ms. Arielle Levine, Master Teacher, Distance Learning.
- Meeting with Mr Kevin Kelly, Distance Learning Technician & Instructor.
- Meeting with Ms. Hajnal Eppley, Assistant Director, School and Teacher Engagement.
- Meeting with Ms. Diane Cizek, Program Coordinator.

June 12 & 13 – Two day visit to Challenger Learning Center and the Bathysphere Underwater Biological Laboratory in Rochester, New York (Part of Monroe #1 BOCES.)
- Meeting with Mr Peter E. Robson, Instructional Technology Specialist.
- Meeting with Mr Andy Raab, Instructional Technology Specialist.
- Meeting with Mr Steven Orcutt, Director of Instructional Programs at Monroe #1 BOCES.
June 14 – Day visit to United States Holocaust Memorial Museum

June 15 – Day visit to Smithsonian National Museum of American History

June 16 – One day visit to Smithsonian National Air & Space Museum in Washington, D.C.
- Meeting with Mr Mark Kornmann, Chief, Education Outreach.

June 17 – Day visit to Smithsonian National Museum of Natural History

June 18 – One day visit to International Spy Museum in Washington, D.C.
- Meeting with Ms Jacqueline V. Eyl, Youth Education Director.
- Meeting with Ms Lucy Stirn, Museum Educator.

June 19 – Day visit to the National Museum of the American Indian in Manhattan, New York

June 21 – Day visit to Building 92 Brooklyn Navy Yard Center in Brooklyn, New York

June 23 – One day visit to Central New York Regional Information Center in Syracuse, New York
- Meeting with Ms Amy Spath, Coordinator of E-Learning & Special Projects & President ISTE SIGIVC.
- Meeting with Mr Jason Clark, Instructional Technology Integration Specialist.
- Meeting with Mr Nick Lefort, Instructional Technology Integration Specialist.

June 24 – One day visit to New York Hall of Science in Queens, New York
- Meeting with Mr Anthony Negron, Manager of Digital Programming.

June 25 – One day visit to Intrepid Sea Air Space Complex in Manhattan, New York
- Meeting with Ms. Kerry F. McLaughlin, Manager, Enrichment Programs.

June 27 – CILC Content Provider Meeting at Center for Puppetry Arts in Atlanta, Georgia.
- Meeting with Ms. Patty Dees, Distance Learning Program Director for Center for Puppetry Arts.
- Meeting with Ms. Ann Hernandez, Director of Programs at Ann Arbor Hands On Museum.
- Meeting with Ms. Corrina Strecker, Distance Learning Manager at Ann Arbor Hands On Museum.
- Meeting with Mr Jason Robertshaw, Digital Learning Developer at Mote Marine Laboratory.
- Meeting with Ms. Karin Davidson-Taylor, Education Officer at Royal Botanic Gardens in Ontario.
- Meeting with Mr Jerry Csaki, Educational Programs Coordinator at Pro Football Hall of Fame.
- Meeting with Mr John Goehrke, Public Programs Manager at Cleveland Rock and Roll Hall of Fame.

June 28 to July 2 – International Society for Technology in Education Conference in Atlanta, Georgia.
- Presented on a panel for the ISTE Interactive Video Conferencing Network: BYOV - Connecting students globally with video everywhere. Panellists were Ms Janet Zanetis, Chief Executive Officer of Center for Interactive Learning & Collaboration
  Ms Pam Lloyd, Senior Director, GCI School Access.
  Ms Carol Teitelman, Coordinator of Distance Learning, Education Service Centre Region XIII
  Ms Audra May, Distance Learning Director, South Central Kansas Distance Learning Network
  Ms Amy Spath, Coordinator of E-Learning & Special Projects & President ISTE SIGIVC.
- Meeting with Ms. Marci Powell, Chair Emerita & Past President US Distance Learning Association and Global Director for Education at Polycom Inc.
- Meeting with Ms. Elaine Shuck, Director Education Americas and Global Director Industry Programs at Polycom Inc.
- Meeting with Mr Greg Zorbas, Alaskan Teacher of the Year, Kenai Peninsula Borough School District Classroom Without Walls program
- Meeting with Ms. Anne Marie Millar, Director of Education & Distance Learning Programs at The Mariners Museum
- Meeting with Ms. Helen Headrick, Coordinator of Educational Opportunities for HEC Television.
- Meeting with Mr Michael Sylofski, Managing Coordinator of E-Learning Services, NERIC.
- Meeting with Mr Lee Bane, District math integration specialist, Barrow County Schools.
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Virtual meeting with Ms. Kasey Gaylord-Opalewski, Digital Learning Coordinator, Mote Marine Laboratory.

Virtual meeting with Mr Galen Sjostrom, Distance Learning Coordinator, Minnesota Zoo.

Watched multiple presentations on educational video conferencing including that by Mote Marine Laboratory, Cleveland Rock and Roll Hall of Fame, Minnesota Historical Society, Philadelphia Museum of Art, Central New York Regional Information Center and the Alaska SeaLife Center.

Main Body

The reality of technology is that hardware and software configurations change, companies rise and fall and what you might know now can be superseded in a matter of months in this fast paced digital world. As such the focus of my research was to look more at how video conferencing was being used by North American sites to improve science education outcomes rather than the technical specifications of particular systems in 2014. I was far more interested in the best pedagogical practices for video conferencing, how this educational content was delivered and accessed plus how emerging technologies could be incorporated into the virtual excursion and formal distance teaching environment. Additionally I was interested in digital technologies that didn’t require large amounts of internet bandwidth, a critical requirement for those sites in outback Australia still confined to low internet speeds. In other words, how can we now connect with any remote audience and why should that audience care? Collecting this knowledge would be definitely be more useful for classroom practitioners and distance educators across Australia than a technical specifications list – after all you can always work closely with an IT integrator or video conferencing specialist to get a particular system up and running once you know what you’re going to do with it in the first place!

This report is meant to inspire any educator working with any audience who wants to expand their learner’s horizons and not simply something to be shelved at the end of a fellowship study tour. Many of the findings can be applied for teachers of any key learning area, not just science. I hope that you as a reader can pass this onto colleagues and teaching associations to inspire more people and students to create their own video conferencing lessons and participate in the global community. In the 21st century workplace it is critical that learners become digital natives that can collaborate effectively across distance and device. Video conferencing (VC) is the most effective tool to achieve this outcome. Let’s be honest, it’s fun too!

Photo courtesy of the ©Royal Tyrrell Museum, Drumheller, Alberta

Transforming Lives & Making Connections

Anne Marie Millar from the Mariners Museum:
“Running a late day program with an afterschool group in California on the Age of Exploration, the presenter heard one of the students lean over to another and say, "Can she see us?" The presenter leaned into the camera and said, "Yes I can!" The entire class responded excitedly. After the formal program was over, the museum presenter spent an additional 10 minutes talking about how video conferencing works, and how The Mariners’ Museum is located on one side of the country while the students were on the other.”

Before launching into the various ways of presenting science education video conferences I want to share just how powerful the medium actually is. One of the things I’m often asked at teaching conferences and professional development sessions is how are learners better off when they participate in a video conference? Another common question is how can the learner have a relationship with someone on a screen? Or worse, “Isn’t this just a streaming video service?” These questions are understandable, especially when some people have not
participated in an educational video conference previously and have not seen the two-way conversations and interaction that occurs. As such I was very interested to collect stories from the visited content providers on their own experiences with students, knowing full well the types of answers I would receive. The following details some of the immense learning impacts that the distance educators shared... and they really are just the tip of the iceberg. Considering that these interactions occur by their hundreds every day for thousands of students across the globe highlights the amazing potential of video conferencing to transform global access and equity in education, especially if it is taken up seriously by educators and it becomes a common place classroom tool.

One of my favourite stories that came up was that shared by the Ms Megan McLauchlin from the Royal Tyrrell Museum in Alberta, Canada. They had been running a program called ‘Up close and Paleo’ to an elementary school in Louisiana. Whilst conducting their presentation one of the students put up their hand through the programme and stated to the class ‘T-Rex has big teeth!’... to which of course the educators replied ‘Absolutely he does!’ and described the dinosaur in further detail. In later correspondence from the teacher in Louisiana the distance team later found out that this child had moderate to severe autism and that this was the first time that the classroom teacher had ever heard the student speak. The thing is, this story in VC is not isolated. When speaking with Ms Patty Dees at the Center for Puppetry Arts in Atlanta she noted that they also have had teachers tell them that an autistic child that does not normally speak in class had raised their hand to answer questions during one of their puppetry VC programs. Ms Jacqueline Eyl at the International Spy Museum in Washington DC also shared a similar story. Students in VC’s with the spy museum are given code names to work with throughout video conferencing - during a session a student with high special needs announced his code name to the class and he had not been known to participate actively in classes prior. I personally have had similar feedback in my work at Fizzics Education a couple of times and now wonder if there is something that could be investigated in future as something in the VC format is clearly triggering engagement from these high needs students.

The ability of VC to inspire marginalised students cannot be underestimated. When speaking with Mr Darin Trobaugh at the Alaska Sealife Center he mentioned that he had previously run a session on puffins for a Return to School program in Dubbo, NSW. He later found out after the conference that one of the girls involved had since contacted her Principal to see how she could get back into school, asking what study paths she would need to focus upon to become a marine biologist and had even asked her family how they might be able to visit Alaska. What a fantastic achievement considering she had only worked with Darin for an hour! On a subsequent VC she made a presentation to her class and other participants about the animals held at the Alaska Sealife Center and their place in arctic ecology. A similar story was raised by Ms Helen Headrick of HECTV, whereby they had an African American artist as guest panellist during a VC. Several young African American students, who had not displayed the best behaviour in classes, connected with him during the program. They displayed their own work to him for critique and commentary during the program and were highly engaged throughout. With the help of the teacher he continued contact with the students after the program to further comment on their artistic work, their class work, behaviour and life in general. The supervising teacher was very grateful and said the personal connection had turned the boys around and that this change in attitude most likely would be long term. Having role models is critical for developing minds. VC can bring a class access to special people not normally available in traditional schooling. A perfect example of which is how Mr Jerry Csaki of the Pro Football Hall of Fame engages famous American footballers to teach goal setting and character building to troubled youth. Mr John Goehrke of the Cleveland Rock & Roll Hall of Fame also described how music was being used reach students with behavioural issues and how creating digital competitions between schools for students to present about why a band should be inducted into the Rock Hall teaches reasoning, debating and presentation skills.

Students don’t come much more marginalised than those incarcerated in juvenile detention. Nearly all of the content providers contacted had been presenting VC science programs to youth in detention across a variety of States, citing how much the 17 to 18 year old offenders appreciate the effort made by educators and the positive impact it has for them. Marginalisation is also apparent in mainstream classes; especially when it comes to language. The East Central Ohio Educational Service Center had run a programme on the United States Symbols to a year 2 class in Dallas, Texas. When asked a question, “What does it mean to be endangered?” a child answered in Spanish to which an adjacent student helped translate the answer into English. This demonstrated to students, teachers and the presenter that the student was comprehending the English language but was still speaking in another language, highlighting to the other classmates that the classroom was culturally diverse and people from backgrounds may have a tougher road in the classroom.

Going beyond spoken language is that of the experiences of students with hearing impairment. Speaking with Lee Gambol at the Cleveland Museum of Natural History she described a situation during a Just Senseless program
whereby she mouthed the words ‘Stand Up’...whereby a profoundly deaf child promptly stood up at her seat whereas the rest of the class remain seated. Until this moment the teacher and students had not fully appreciated how this student had been using lip reading to understand what had been occurring in the classroom. Ms Dale Hilton from the Cleveland Museum of Art also commented on the effectiveness of arranging a hand signer to attend VC lessons with the Ohio School of the Deaf during a programme on Egyptian Mummies, a positive experience also shared by the Center for Puppetry Arts in VC’s with the Kentucky School for the Deaf. The Royal Tyrrell Museum also has offered programming services to deaf and hard of hearing students. The Cleveland Museum of Art also ran a VC for a school for the visually impaired by sending tactile materials such as pottery & travertine to the remote site. The presenters, teachers and students found the program highly rewarding as the students described the materials by touch which encouraged strong communication and descriptive skills.

An inspiring use of VC described by a number of content providers was that done teaching chronically-ill students in hospitals using a variety of non-H.323 solutions such as Zoom, Field Trip Zoom, Google Hangouts, Blackboard Collaborate, Safari Montage Live! or Skype. Major operations and procedures often take a large amount of schooling away from children and as such this work helps to bring education into these environments. The education team at the New York Hall of Science (NYSCI) has found that once the patients recover and join mainstream classes that the students continue to keep in touch with the presenters. Mr Anthony Negron of NYSCI also noted that they have also run similar classes to home based pregnant teenagers to great effect. An interesting take on hospital VC presentations is that run by the Center for Puppetry Arts which works with the Voorhees Paediatric Facility (VPF) at the Bancroft School. The VPF is the first New Jersey Department of Education approved private school located within a pediatric specialized care facility and services the educational needs of children who are medically fragile, technology dependent and require continuous skilled high-level nursing care. Kinesthetic activities related to puppetry have been adapted to the audience and provide the nurses an opportunity to work with student’s mobility and circulation through gentle movements such as moving arms up and down like a butterfly in their Butterflies program. Further rehabilitative work occurs during these programs whereby the nurses assist the students with puppet building as they learn about butterflies and spiders.

Video conferencing provides a platform for real engagement across time zones and doesn’t need to be difficult or planned. NYSCI was once engaged in a Blackboard Collaborate VC on microbes with students in Sereolippi, Kenya. Finishing early, the students were ‘brought into’ the video conference room...literally via carrying the laptop computer into the distance learning room. Here the Kenyan students met some New Jersey students who were participating in a Fun with Bubbles K to 2 program. Simply focussing the desktop camera onto the VC monitor and vice-versa meshed the platforms. The idea of time zones and other cultures intrigues student. Ms Anne Marie Millar of the Mariners Museum, Virginia described how they were running a VC program on Life at Sea to students in Australia during which the students were fascinated by the fact that the Museum was on the opposite side of the world from them. The conversation then evolved into one of time concepts and how “Australians were always in American’s tomorrow” and that American students were always in Australia’s yesterday. I can speak from a lot of experience in running VC’s to North America... this never get old!
Creating connections between remote communities via VC opens up the possibility of cultural exchange and mutual understanding. Many of the VC content providers sites had connected to Alaska libraries via the Owl Project coordinated by the Alaska State Library as well as a variety of connections to schools other countries. I spoke with several Educational Service Districts who all praised the fantastic opportunities to connect school classes on different continents. Speaking with Mr Greg Zorbas I heard the work done to transform his Kenai Central High School history class to form the Classroom without Walls project whereby students regularly connect with sites across the globe and often sleep overnight in the school to allow for time zones!

Students consistently report a strong connection to the educational content during a video conference. Whilst speaking with Ms Karin Davidson-Taylor of the Royal Botanic Gardens in Ontario she relayed a story that occurred during their insect program Creatures with Wings and Crawly Things. During this program she asks that the class go outside and see what they can find living in their school yard. One teacher wrote back to say that “she couldn’t get them back inside.” This occurrence highlights is the whole point of VC presentations - video conferences are not a replacement to local exploration but an avenue to give classes the strategies and tools to explore further and inspire the students to seek deeper understanding. All of the content providers interviewed described stories of true engagement by remote students and their absolute joy to connect with specialist content providers. Mr Peter Robson from Monroe #1 BOCES described how on concluding a visit to Bathysphere Underwater Biological Laboratory a high school student from a tough inner city low socioeconomic district was highly emotional, exclaiming that the visit was his ‘best day ever’. This student reaction is actually quite common occurrence for VC science outreach providers and also often extends to teachers reactions too. This couldn’t be better than that described by Mr Galen Sjostrom of the Minnesota Zoo who recounted a kindergarten teacher who enjoyed the Zoo Food program so much that she and her class sent the Zoo a home-cooked fruitcake in the mail to share! The connection to students doesn’t need to be ground breaking however; an example of this was during a VC connection where I watched a New York school and the Alaska SeaLife centre strike a simple conversation on the presenters personal stories of whale watching on boats and kayaks in Alaska and which he then compared that lifestyle to that living in New York city. Many providers such as the Aquarium of the Pacific, Mote Marine Laboratory, Ann Arbor Hands-On Museum, Minnesota Historical Society and the Smithsonian National Air & Space Museum receive regular ‘fan mail’ from excited students across the USA and beyond with the teachers describing the kids constantly talking about their positive experiences, a testament to the connection made with students.

Video conferencing also offers the opportunity for students to connect with high level management and experts. Ms Janice Hicks Slaughter of the Nina Mason Pulliam Ecolab (NMPE) within the Marian University described presenting a video conference on epidemiology to a group of high school girls whereupon the president of the University happened to come through the building at the time. He quickly joined the conference and started speaking candidly about campus life and encouraged the students to visit the schools on open day. The students were clearly engaged with the conversation and appreciated the unique opportunity given to them to speak with a high level official. On another conference a cancer researcher visiting Marian University on a Vera Bradley Fellowship also spoke at the NMPE with high school students about her research, about possible University career pathways and students healthy living practices. Such VC connections helped Marian University to place itself into the minds of potential students and promote tertiary education in general. The International Spy Museum described a regular video conference session called The Spy’s Eye View where students step into the secret world of spying in a briefing with a former CIA Case Officer; where else could students get to meet a former spy?
Personal connections during VC are just as important as the content being presented and this not just for school students. Nearly all of the visited content providers run workshops for seniors in retirement homes. During these presentations it is often the ‘learners’ that do the teaching! An example of this is when the Cleveland Museum of Art ran a VC lesson on Harlem Renaissance in the 1920’s to a retirement home. Whilst discussing about Jacob Lawrence’s paintings on the Great Migration a retiree relayed to the group that he had worked with the artist personally and was able to share personal stories to the delight of the attendees.

Personal connections extend to the teachers as well. The Cleveland Museum of Natural History (CMNH) administration staff described the relationships developed over many years with teachers when scheduling classes, so much so that the teachers make a point of seeking out the team when arriving onsite at the museum with their own families. This strong connection was further demonstrated by a school in the Oceanside school district on Long Island that had been devastated by Hurricane Sandy. Two of the Just Senseless hands-on kits that had been given up as lost by CMNH were returned by the teacher despite the additional stress of getting the school back to together.

So many inspiring stories were shared during my 7 week trip. North American content providers have been working with child care centres, community centres, special needs groups, cyber academies, home school groups, after-school programs, summer camps, lifelong learning programs and more let alone the thousands of interactions with K to 12 school groups, libraries, prisons and retirement homes. I think that Ms. Karin Davidson-Taylor at the Royal Botanic Gardens summed up the attitudes of VC content providers the best, “If there is a need, we’ll find a way to interact.” Couldn’t put it better really! And the best bit... it is getting easier and easier to do now with cloud-based solutions and downloadable apps that can make any desktop or smart device join a video conference connection easily, even on low bandwidth connections.

So having gone through some of the real life connections and positive impacts that VC educators have made during the course of their work it should be asked just what makes these experiences so engaging? We’ll explore this in the next section...

What makes great STEM VC content?

A great Science Technology Engineering and Mathematics (STEM) video conference presentation doesn’t just contain facts and figures, it engages the learner at multiple levels and responds quickly to the teaching environment at hand. As Ms Julia Heighway from Centre for Interactive Learning & Collaboration put it, “The best content occurs when you consider what the students get to do.” Consistently educators recommended that the content needed to be relevant to the learner, i.e. fun and interactive. Importantly a number of content providers cited the need to be flexible to adapt to learners questions and inquiries during a conference and not be bogged down by the need to ‘keep to the script’.

Ms Lee Gambol from the Cleveland Museum of Natural History suggested that when training new distance educators that they reminded that they continue to be open to try new techniques as they become available and have fun with it... but still be acutely aware of the needs of the students and teachers no matter how impressive the technology evolves.
On speaking with a variety of VC professionals the process of creating engaging content involves a consistent formula irrespective what topic is being taught via video conference:

1. Brainstorm the topic;
   - a) What’s great about it? Why would the learner care? What relevance is there to today’s society?
   - b) What content can be tangibly demonstrated to the students in a VC?
   - c) Are there opportunities for students to use hands-on science materials in the VC?
   - d) Can the remote site access these science materials easily or do these need to be sent out?
   - e) How can the current technology available be best used to achieve the STEM goals of the VC class?
   - f) Which classroom management issues might arise? Devise strategies to mitigate.
   - g) Allow time for questions from the learners throughout the VC and at the end to ensure understanding

2. Place the developed STEM class into the correct year level.
3. Finally link the session to curriculum standards appropriate to the country and State where it will run.
4. Offer the class to a pilot school and take feedback from teachers and students.
5. Re-visit step 1 and improve the STEM VC content.

When applying these steps appropriately it really means that any piece of educational content can be adapted to the video conferencing medium. As long as the learner can see and hear the content clearly, the topic is pitched engagingly at the right developmental level and there is a chance for learners to run their own science experiments even simplistic lessons captivate students. I asked for thoughts from the visited sites on what they would consider hallmarks of best practice in science education via video conference.

- Students using hands-on materials in their own classroom (whether mailed out or sourced locally).
- The lesson broken into distinct segments;
  - i.e. introduction, demonstrations, hands-on experiments & discussion/questions/surveys throughout.
- Incorporation of multimedia eg. video clips, animations, games, surveys, shared documents.
- Integration of multiple viewing angles of the presenter and the demonstrations i.e main camera, 2nd camera, document camera & chroma-key green screen technology. Dedicating a staff member to run an A/V mixer makes the transitions between the digital content seamless but this is more costly for the content provider.
- For elementary students it was seen as important to incorporate kinaesthetic activities where possible.
- For pre-schoolers and kindergarten students the use of songs and stories plus simple craft support the lesson and adds additional learning outcomes.
- Preliminary work, lesson vocabulary sheets and post-lesson materials for further investigation were seen as highly useful by teachers to achieve STEM learning outcomes for their students.
- Incorporation of BYOD; also known as “bring your own device” for students (eg. tablet, computer or smartphone). This is a new development and will build as BYOD is adopted in schools.
- Presenter ability to use multiple video conferencing platforms to suit the needs of the audience.
- Curriculum relevant lessons and flexibility of delivery for different learners.
- Sustained internet connection between the sites throughout the VC at the best bandwidth available. Whilst presentations could be run at 256kbps the reality is that transmission rates from 768kbps and up provide the best high definition experience.

Some STEM presentations discussed required student to make notes on worksheets for upper grades for future reference however there was no requirement for younger students to do this due to the time young students take to write down answers. Essentially it was seen as more important for students to interact with the unique aspects of a particular cultural site (i.e. special artefacts, experiments or an expert presenter) rather than doing book work doing this valuable time.

Wherever possible it was recommended that student numbers were kept as low as possible so that there was a fair chance for students to ask questions as well as interact with the learning materials in the room. Generally most cultural sites visited run their video conferences as 1:1, meaning just one remote site and the VC presenter only. Running a session 1:1 allows for optimum interactivity between the learners and the presenter, however it does make it more challenging for the institution presenting the conference due to the costs of staffing the conference and the low funding levels of some of the participating schools. To mitigate against this most of the sites visited offer multipoint presentations whereby several sites could share the costs of connecting to a virtual
excursion provider. In this case it was recommended that the number of connections be limited to 3 remote sites where possible to maximise interactivity.

**Video conferencing teaching practices used**

Firstly every site visited sent pre-lesson, during lesson and post-lesson material as .pdf files to the remote sites they were to connect to prior to the actual date of presentation. Within these materials there were:

- Prior STEM vocabulary lists to prepare students for the language about to be used in the conference.
- Suggested reading on selected websites and reference books.
- Suggestions of preparatory hands-on experiments that could be run prior to the lesson.
- Brief descriptions of the hands-on experiments that students would do on-site which would include a shopping list for materials, a description & photos of the activities and any student handouts required during each session.
- Extra STEM activities to do after the VC to extend student learning.

Many sites could customize VC programs to work with the teachers and their curriculum needs, with the ability to adjust the content or develop entirely new workshops to suit the teacher’s objectives for their classes.

During this Churchill Fellowship I had the opportunity to watch a variety of talented educators run their own VC presentations where I got to see a number of presenting styles, techniques and technologies. Each presenter had their own style; some were more dramatic whilst others were more conversational but all grabbed the learner’s attention through humour, questioning and conversation. The next section details some great devices that were shown to be effective in delivering science education remotely. It should be noted that whilst I saw a number of live VC connections I did not get to watch every provider present a class due to there being no available remote site to connect to at the time of my visit. Regardless, I was able to spend quite some time at each site talking about how their programs were interactive for students and found a lot of great information. To keep it brief I have chosen a few providers in each section to describe in detail.

**Video conference devices & delivery**

The old adage “What you see is what you get” more or less applies in a VC setting. If you can get an image on your desktop computer and you have sound you can transmit the information, as long as the connections are made correctly on your hardware and you are using the right software.

Essentially you can run nearly any device via a VC system in a conference call, whether you’re using a proper video conference system or simply using a computer with a web camera.

You can use A/V connections, HDMI or coaxial cabling direct to the VC unit or simply connect your device via Bluetooth or USB to a computer already linked to the VC system. This could be a digital microscope, a DVD player, an Xbox™ or more! Alternatively web conferencing allows you to do that directly from your computer or smart device (software dependent).

The following details the types of video conference systems available and some of the additions VC systems I saw that were arranged to improve the educational delivery of a VC science lesson.

**H.323 Video conference systems**

There are a variety of formal video conferencing systems that have been installed in schools, libraries and more over the past 20 years. Generally a VC system incorporates a codec (the heart of the system), a microphone, a camera, an internet router, associated peripheral cables and either a television screen or data projector for vision. Some sites incorporate a server with a firewall and some sites don’t. Some sites may have a bridging MCU server system attached to the VC unit which allows for 4 or more remote sites to be called at once, other sites may have a codec with a mini-bridge capable of handling 3 remote sites plus themselves and finally other sites have older systems that can only handle 1:1 video conference calls. The bottom line is that the actual equipment you encounter in any distance learning room really is a function of budget and when it was delivered.
Listing all of the different variants would be tedious however a number of large vendors supply video conferencing equipment that all use the same H.323 standards based operating algorithm which means that the various systems can communicate with each other over a common digital language. Depending on the age of the equipment it may transmit in high definition or in standard definition over varying internet speeds (the higher bandwidth the better the image and sound clarity). Generally most video conference calls placed by the contacted VC content providers on H.323 systems would range between 256kbps up to 1980kbps depending on both sites internet capabilities, although most content providers noted that they often run programs at between 384kbps and 512kbps. From my own experience I’ve seen connections into the USA in glorious 1980kbps high definition all the way down to grainy 128kbps... it really depends on what internet infrastructure has been organised by the receiving sites.

The major brands of H.323 video conferencing equipment include Cisco™, Tandberg™ (recently bought by Cisco™), Polycom™, Lifesize™, Sony™ and Radvisio™ (now Avaya™). They all can have additional equipment connected to them and can move their cameras freely and focus on small objects in very fine detail. In essence a H.323 system is exactly what is needed to run a fully-fledged distance learning room as it has all the refinements needed to run VC lessons as well as the high definition movable cameras and noise cancelling microphones that produce a high production value experience for a receiving site.

Web Conferencing Solutions

During my trip it was interesting to hear how VC educators were finding that schools and other sites are now wanting more options for video conferencing beyond their installed H.323 systems. Some teachers were found to be needing further flexibility to broadcast from any device or location in their school where as other remote staff were noted to struggle with the H.323 format in general and wanted something that was simpler.

A major move in the past few years is for video conferencing solutions that do not use special H.323 equipment and so meets the needs of teachers needing ease of use, flexibility and low cost installation. In this I found that there are many, many solutions of varying degrees of picture/sound quality, software functionality and reliability. Some of these solutions are free where others have monthly subscriptions. Regardless of configuration, these software types come under web conferencing which involves a computer or smart device using software that is either cloud-based or downloaded onto the device.

Preferred functionality in web conferencing by VC content providers were as follows:

- Ability to communicate in a back channel via a chat room.
- Ability to share a desktop to show spreadsheets, worksheets, illustrations and so on to learners. This was especially valued if the remote learner could annotate the document on the presenters desk.
- Ability to conference with many sites at once.
- Stability of image and sound with no video call drop outs or freezing of images.
- Ability to moderate the distance learning room i.e. remove unwanted guests and moderate student language.
- Ability to connect across as many devices as possible.
- Ease of setup and user friendly in design and intuitive to use.
- Ease of scheduling sessions through the software itself.
- Ability to record the web conference when needed.
- Good firewall traversal and not blocked by networks.

There are two types of web conferencing software systems I encountered on the trip:

1. Software solutions that connect with most devices except H.323 video conference units eg. Google Hangouts on Air™, Skype™, Adobe Connect™ etc. Many of these are well known and used by the mass market.

2. Software that has the functionality to connect to any system that runs H.323 or SIP encoding (aka standards based conferencing) Eg. Zoom™, Field Trip Zoom™, Pexip™, Blue Jeans™, Acano™, Cisco Jabber™, Polycom RealPresence™, VidyoRouter Virtual Edition™, Safari Montage Live!™ etc.
These are less known by the general public and schools.

There are many other software solutions other than these mentioned, each with varying degrees of functionality and price. The second type of software were those that very much interested me, as these software types were not exclusive to a particular system and could connect a desktop computer, iPad, Android device or H.323 VC system together. The potential for these software types to change the face of distance learning is staggering; most people in 1st world countries already own internet devices (smart phones, tablets and computers) that can connect to a specialist VC educational provider with H.323 equipment with these web-based solutions...which means that access to high quality educational experiences can now be ubiquitous and equitable regardless of location. You just need an internet connection.

In terms of web conferencing software that was being adopted by many providers Zoom™, Google Hangouts™, Field Trip Zoom™, Safari Montage Live!™, Cisco Jabber™, Polycom RealPresence™, Skype™ and Blackboard Collaborate™ stood out as being most popular. Several providers mentioned that it was handy to have several options up your sleeve in case one system fails to work. Which brings up the point, the digitally literate 21st century learner expects a device and software to work instantly, without hassle and in high definition with low bandwidth usage. As such the software types that don’t require a physical download (cloud-based) and work across multiple devices in high clarity (H.323 standards based and with low bandwidth usage are going to be highly sought after by those who wish to consume future distance learning opportunities. If it could be accessed via a cloud server, eg. Zoom™, and have as much functionality as possible it would be more likely taken up by educational consumers.

Green screen (aka Chroma Key)

Throughout the trip it was clear that the adoption of Chroma Key (green screen) connected to H.323 systems was seen as important by content providers looking to keep ‘cutting edge’. Before the introduction of green screen technology presenters only had the option of bringing in extra digital content by feeding in a laptop display from a separate video stream. By using an A/V mixing station and a skilled operator the VC presentations could be changed from simply showing multiple camera angles to an educator being able to present like a weather person over the top of changing animations, game scenarios, dissections or other presented imagery. A fun way to introduce a VC session was to use the Chroma key to present their institution’s locality by ‘flying’ from the remote school to the institution’s address by utilising a Google Earth™ animation. Whilst that could be done via a simple laptop feed it could be quite fun to see an educator pretend to transport themselves form one site to another!

Green screen comes into its own when touring museum galleries, exhibits and items. When watching Knights, Castles & Kings by the Cleveland Museum of Art the students were able to see a variety of artworks were portrayed on screen whilst the presenter pointed out the features to link the artworks to lifestyles and beliefs of the time. The Minnesota Historical Society often dresses up in period costume in front of a green screen with props and encourages role play for students to act out historical characters with the green screen being used to bring in footage from 26 sites.
The downside seen for green screen technology was the additional cost of establishment as well as the need to configure the room lighting to suit the medium. Another issue identified was that the remote site needed better bandwidth otherwise pixilation of the image could occur (although in newer systems this was less the case). I found it interesting that there was a tendency to use the green screen view as the major source of visual content if a VC provider had the technology. This is understandable given the investment and the ‘bells and whistles’… but I also saw no real difference in educational quality exhibited by sites that did not have the technology. Green screens more increase the options for teaching interactively via video conference, although it was clear that having a green screen presentation increases the production quality by bringing in title screens, countdowns, content items and subtitles in combination with the educators being placed on-screen.

A perfect way to use a green screen is via Flash™, Keynote™ or PowerPoint™ animation games. Each presentation I saw was clearly student centred, fun and obviously rewarding for the students. During my visit to the Aquarium of the Pacific I watched a presentation to a middle school in North Dakota called *Fishial Pursuit*. Apart from getting additional points for the pun in the title, I enjoyed the lesson design whereby the remote class was split into 2 teams to compete to answer a variety of questions on marine biology. The sessions pulled in pre-recorded grabs as well as live views from the aquarium to which students had to answer questions posed by the voiced-over animals.

I also saw a great demonstration of how *PIQ: Test your Paleo Intelligence* at the Royal Tyrrell Museum, a K to 2 presentation which requires students to answer basic palaeontology questions to get the dinosaurs to a picnic before a volcano erupts! I could imagine this presentation being well received by even pre-schoolers, the graphics were stylised to suit the audience. It was interesting to fund out that as the Royal Tyrrell Museum has recently upgraded its systems to HD delivery so it’s previously created footage and flash animation needs to be updated to go with the output as well.

The Minnesota Zoo ran a short presentation of *Zoo Food for Thought* whilst at the ISTE conference. The presenter showed how this primary program had students choose the right answers from multiple choice questions on which animal diets suit which creature. Again this was presented in a light hearted manner but allowed students to explore the difference between carnivores and herbivores as well as the location of the different animals.
around the planet. Interestingly the Minnesota Zoo did not need an additional technical person to run a mixing desk as all of the settings were controlled via a touch pad near the presenter.

Running games via VC doesn’t need a Chroma Key however, it just looks nice when done that way. Mote Marine Laboratory runs a great session called *Sea me Read: Clumsy Crab* which quizzes students on retained content from a book via a series of animated questions presented as separate animations into the conference and is just as effective. The Center for Puppetry Arts also runs animation games directed into the conference during their *Dinosaurs* program.

Document cameras

Showing detail of biological and abiotic structures is essential for a science educator. A high definition document camera connected to a video conferencing system allows for the minute structure of organisms and artefacts to be shown in great clarity, especially if a video conference is run at internet speeds greater than 1024kbps. This is no surprise as the greater the number of pixels being transmitted the better the student experience, especially with modern TV’s and data projectors being able to project images in high definition 1080p. Personally at Fizzics Education I’ve experienced using a document camera during a 1980kbps video conference call and the clarity was indiscernible from actually being there in person (if anything better as the focus is better than the naked eye). Most of the visited video conference content providers used document cameras to great effect.

On visiting the Aquarium of the Pacific they were able to run a market squid dissection for a class of roughly 24 year 9 & 10 students. Prior to the conference the educators had sent the squid via courier to the schools with additional instructions on how to setup the classroom. After initially covering the taxonomy of Phylum Mollusca the presenter guided the dissection using a document camera with help from the classroom teacher as a facilitator. The students worked in pairs and threes to identify a variety of features of the squid with the presenter continuing to ask questions, give answers and discuss functional anatomy throughout the conference. Pulling the video feed through the green screen allowed the presenter to point out the features of the squid and maintain a personal connection as an educator with the students.

A dissection presentation is highly student centred and was well received by the students and teacher. This type of conference is popular with students, with both the Alaska SeaLife Centre and Mote Marine Laboratory also running similar dissection programmes for marine biology.
The Royal Tyrrell Museum had rigged an extra video conference camera from the roof to focus downwards upon a presentation desk to act as a document camera. This was a highly effective use of a second camera which could also double as way for students to view the supporting technician situated in the corner of the room at the A/V mixing desk! During the visit I saw an up close view of an *Albertosaurus spp.* tooth under their second video conference camera. You could see the fine detailed serrations along the tooth margin which made for a strong teaching opportunity. The image below shows the sort of detail in an amber fossil that was able to be shown.

The Alaska SeaLife Centre had a document camera attached to a mobile VC unit that was wheeled into the middle of the aquarium public area. During a *Marine Mammals and Adaptations* presentation to Year 4 students on Long Island the students were guided on how to make seal models using modelling clay and card. Darin was also able to show otter fur clearly to the students and relate this to the animals swimming nearby. Darin also described how they can send out seal scats to schools for discussion of diet but noted it can be expensive to organise. A solution for this is to have some scats prepared to show under the document camera.

Document cameras are very useful when showing construction of objects. The Cleveland Museum of Art used this to great effect whilst presenting a workshop on Medieval Warfare. Here the students could clearly see how to turn simple materials into a rudimentary onager. In the photos you can see the importance of colour contrast and that of keeping objects clearly separated so that they can be discerned by the remote viewer.
Use of camera presets during teaching

For veterans who have used H.323 video conferencing units before this is very straightforward. Yet, it’s still worth mentioning as the many remote sites that VC content providers connect to have not learnt how to use their VC system remote control and so miss simple yet effective ways of transitioning between different views throughout the room. The procedure differs slightly between each conference system however it usually involves moving the camera to a desired view and then holding down one of the number buttons on the remote until the TV displays that a particular camera pre-set view is stored. Once this process is repeated for each view needed the teacher or student simply can transition between each pre-set view quite easily and professionally. The reason for this is that it is cumbersome to move a camera during a conference; often the camera moves to past the area needing to be shown or the image becomes blurry which you then need to refocus.

A great example of simple yet effective uses of pre-sets during my visit was shown at the Alaska SeaLife Centre. The movable trolleys were placed in the middle of the aquarium floor, allowing clear line of site to 3 holding tanks and the live feed to Chiswick Island Stellar Sea lion population 35 miles away. Using camera presets allowed for quick transition between views of the tanks, the document camera, the presenter and DVD pre-recorded footage. The students loved the shots of the seals and clapped when shown footage of seals hunting fish. Close up views of Otter and Stellar sea lion skulls were effective, especially from an adaptations point of view.

Like many sites, the Cleveland Museum of Natural History uses a touchscreen system on the presenter desk to control camera pre-sets from the presentation desk. This was highly effective if required to present a lesson with multiple camera views & A/V feeds without an additional technical support officer running a A/V mixing desk.
Second VC Camera

Using a second camera effectively really enhances a presentation. The Cleveland Museum of Natural History (CMNH) uses a second camera positioned so that the students can see themselves to allow the students a personal insight into what the educator sees. This was especially fun when the person holding the camera was a skeleton!

Lee Gambol at the museum also employs a brilliant use of VC equipment capabilities during presentations on 5 senses to kids where she deprives the kids from audio or camera views to simulate impairment.

Other camera uses

Video conferencing does not have to be confined to dry land too! Apart from using a standard distance learning room Mr Peter Robson at Monroe #1 BOCES also uses dive equipment in a local pool to teach geometry and buoyancy. Here he uses a full face Otterbox™ mask, camera and cabling to provide students with a unique presentation from underwater. Unfortunately we were not able to arrange a school to see this in action but the idea sounds great!

Both the Aquarium of the Pacific and the Minnesota Zoo have installed static cameras in their animal exhibits to throw to during their VC presentations.

iPad holder

On visiting the Central New York Regional Information Center (CNYRIC) I got to see a Swivl™ in action. Here an iPad can be fitted to the device which then rotates to follow a presenter who wears a transponder around their neck.

This device is very handy for presenting using a non H.323 VC solution through an iPad, I’ve been wanting to get one of these for a while now and it was great to see one in action!
Supporting remote school sites

The following details some general teaching practices of the various VC education teams to support remote schools at each site.

Sending specimens for remote use

The Cleveland Museum of Natural History often sends out boxes to schools with supporting materials for the conferences (eg. Balto: A hero of humans, huskies and health in Alaska). Delivering boxes for schools to use during a VC can busy enough that some program boxes are replicated up to 3 times to cover demand. An issue identified with sending boxes to schools is that it can be too difficult to run send them across country borders due to customs declarations, where in this case the workshops would be adapted to be run without sending materials. It was discussed how it was important to ensure that the sent items can be packed easily and to choose items that not likely to break with courier and student handling.

Cleveland Museum of Natural History – Boxes sent to schools and contents such as a Dunkleosteus spp. jaw bone replica

Another interesting content sent out to schools by CMNH surrounded that on teeth wearing. Samples of teeth, Vernier™ callipers and instructions are sent through to the school for during VC use.

Cleveland Museum of Natural History: Kit sent to schools on measuring teeth wearing

Monroe #1 BOCES also sends out boxes to schools with supporting materials. Examples of this are:

a) Fun with Energy Transformations: circuit materials plus a cartoon book made in house by the staff.
b) The Rise and Fall of Buoyancy: Students encapsulate a ping pong ball with clay.
c) Diving into Geometry: compass, tape measures.

Monroe #1 BOCES – Fun with Energy Transformations kit materials sent to schools
The Cleveland Museum of Art sends boxes to schools with supporting materials as well. These materials included beads and furs for simulation of trade in North America or materials to make catapults in their simple machines workshop linking to European Middle Ages. The Mariners Museum, Ann Arbor Hands-On Museum and HECTV also mail supplies for the students to use during the connection. In all cases sending items to remote sites comes at a cost and so the VC content must have good volume of work to cover the costs, even with some of these costs being passed onto the remote sites. Some providers had organised a relationship with a courier company to reduce the costs however the fees saved were nominal at best.

Broadcasting in other languages

Having access to multilingual staff adds an extra dimension to presentations and helps support more student needs.

- The Cleveland Museum of Art broadcasts in English, French, Spanish, Italian and German and has had support from a teacher who can speak Mandarin.
- The East Central Ohio Educational Services Center has daily Chinese video conferences to promote cross-cultural education via 3 guest teachers employed from China to work in Ohio.
- The New York Hall of Science presents via English and Spanish plus American Sign Language where needed.
- The Royal Botanic Gardens in Ontario broadcasts in English and French.

BYOD

Student BYOD; also known as “bring your own device” was seen a major step in collaboration at the International Society for Education conference. Mr Jack Matheson from the Minnesota Historical Society presented to a captivated audience at ISTE on how he has students communicate with their smart phones, computers or tablets during a conference via text message or within a website to contribute ideas to a VC lesson.

Three separate websites were being used by the Minnesota Historical Society to great effect. Importantly these sites were chosen because as at the time of the 2014 ISTE presentation they each had free functionality options within their respective websites. By using a moderator during the conferences the addition of BYOD could be made safe for school lessons and allow students to participate who may not want to speak openly in a classroom.

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Room Configuration

The design of distance learning rooms, whilst similar, were dependent on whether a Chroma key was in operation, if the public were able to view the sessions and if the room was used for other purposes. Many sites who performed live science experiments had their educator presenting from behind a desk whilst facing a television screen, usually within close access of a document camera and support equipment. Camera pre-sets were controlled either by the VC system remote control or a programmed touch pad on the presentation desk itself. If the green screen was employed the presenter often stood directly in front of the green screen and relied on support from an operator at a mixing desk. The following shows the various configurations of the distance rooms seen.

Distance learning rooms incorporating an A/V mixing station

Several sites had purpose built video conference rooms with green screens and associated technical support. Much attention had been given to the lighting, sound and ability to mix multiple audio and visual elements to VC lessons. In the Aquarium of the Pacific the distance learning room was situated directly adjacent to the education offices, therefore requiring substantial sound proofing in a purpose built room. The ceiling had an array of lights for clear lighting of the green screen. The document camera was situated to the left of the presenter. To the right of the presenter was a good use of a slave monitor whereby the presenter could point to ‘objects’ on the green screen and get her hand in the right spot. A simple yet effective way of time keeping was a large clock placed directly next to the TV receiving the school content. The presenter used a headset microphone for sound clarity with support from mixing desk. 10 separate cameras situated in the aquarium areas brought in live feeds of animals during the broadcasts eg. Penguin nest box, sea otter tank, wrasse sex change tank, jellyfish tank, coral reef tank, shark tank etc. The combination of green screen use and live feeds required the help of a technical operator on an A/V mixing desk to bring the digital feeds together.

Aquarium of the Pacific

The Aquarium of the Pacific setup had some parallels with Cleveland Museum of Art. In this case they were setup in the basement of the building in a well-designed studio. Quite a large A/V mixing desk was situated to one side of the room and the educator presented from the centre of the room with a document camera available if needed. Again presentations were done with a headset microphone – a good example of having backups was at their mixing desk where they had a large number of backup units for the microphone in case it went down.
and to the side of the presenter was a fantastic array of lighting which allowed the green screen to function properly (shadows cause pixilation and loss of crisp images).

The Royal Tyrrell Museum combined the use of a green screen, a presenting desk and a 2nd VC camera on the ceiling that acted as a document camera to the left of the presenter. From this setup the presenter could transition seamlessly between green screen and a presentation desk. The presenting desk had drawers with available materials to present with and there were a variety of screens that the educator could see during the conference to help with knowing which pre-recorded slide or animation was coming next. As per the Cleveland Museum of Art and the Aquarium of the Pacific the technical operator supported the lesson. In all three cases the technical operator also had sound knowledge of the lesson content itself, therefore they could swap with the on-camera presenter as needed, especially during busy presentation days where up to 5 lessons might be run back to back.

The Smithsonian National Air & Space Museum approached their video conference space differently. In this case they had a centre stage arrangement in the Moving beyond Earth public gallery whereby the entire site acted as a TV studio. This site has a mixing studio underneath the galley which allowed for any VC session to be simulcast on NASA TV during major productions. Being situated in the public galleries means that video conferences involves live audience interaction, just like a television studio.
Smaller distance learning rooms

The NMP Ecolab at Marian University, Cleveland Museum of Natural History, the Centre for Puppetry Arts and the International Spy Museum showed how simplicity can still achieve effective STEM lessons. In each case the presenter worked behind a desk and presented materials directly to the main camera, with a supporting document camera available when needed. The emphasis of these science lessons was on physical materials in the educator’s hands and hands-on experiments for students in the remote sites. An effective use of space was within the Cleveland Museum of Natural History which stored a variety of its materials within their 2 distance learning rooms.

In the case of the Monroe #1 BOCES Challenger Learning Centre an effective use of space was shown with a green sheet behind the presenter in quite a small room which actually helps with deadening the echoes. A simple analogue clock to keep the time completed the setup!

The Centre for Puppetry Arts had two VC systems within the same room. One of these was from older legacy standard definition equipment still operational from a previous installation.
A good use of a distance learning room for public viewing was seen at the Smithsonian National Museum of Natural History, whereby its distance learning room was adjacent to the Q?rious hands-on lab. A well lit room and attractive floor to ceiling glass walls with butterfly motifs completed the look.

Smithsonian National Museum of Natural History

Between room VC

A novel use of video conferencing design was shown by at the Bathysphere Underwater Biological Laboratory (BUBL) and the Rochester Challenger Learning Center. Both operated by Monroe #1 BOCES, each site had the ability to have classes visit in person and participate in 2 hour simulated experiences of either commanding a space craft or performing science experiments in an underwater laboratory. In both scenarios the visiting class was split in two so that they would run simultaneous experiments in different rooms. The rooms were connected via video conference so that students could communicate between each ‘site’ to simulate a mission environment. Very effective medium for the visiting students, it was very clear that they were immersed in the experience from start to finish.

Rochester Challenger Learning Centre  Bathysphere Underwater Biological Laboratory

At the Challenger Learning Centre and BUBL the school participates in a preparatory video conference prior to the school visit to prepare for experience. The students were split into teams and then work at high pace to simultaneously to produce the lesson outcomes in both rooms. Students need to share information to solve problems and communicate between sites as paired teams. The team approach meant that teachers could place students into teams that they are best suited in. The presenters were connected via microphone and headset to coordinate the 2 hour session. Students take photos throughout the session which are accessed later via website login.

At the Challenger Learning centre the STEM outcomes covered and shared via VC between sites included simple circuits, geology, magnetism, energy, human biology, mapping, robotics, acid/base chemistry, code breaking, the solar system and more. At the BUBL site the STEM outcomes covered were density, buoyancy, invertebrates, mass spectrometry, archaeology, robotics & Computer Aided Design (CAD), food webs, digital microscopy, filtration, MSDS, navigation and more. Both sites were in addition to the separate video conference room that Monroe #1 BOCES broadcasts to remote sites.
Moveable VC units

As discussed at the Centre for Interactive Learning and Collaboration, the ability to move VC systems within a site allows greater use of the infrastructure purchased by a particular group. Sites that have movable systems are more flexible in terms of being able work around competing needs for a given space as well as are able to show other views of a particular site.

Several sites I visited used moveable video conference systems, with the video conference codec, TV, cabling, microphone and accessories all on a trolley. To enable this to work the site must have either a consistently strong WiFi signal throughout the site or have internet ports throughout to allow for consistent data signal. When I visited the Alaska Zoo they had just completed the process of getting the Zoo setup with WiFi repeater units throughout the Zoo with the help of GCI School Access. Clear transmission from the WiFi unit to the video conference trolley was considered to be paramount to ensure that the remote schools would get a great VC experience. When speaking with the Smithsonian National Air & Space Museum they noted this can be an issue and so are planning further upgrades at their site to mitigate. In fact the very nature of a museum may preclude the use of movable VC; on visiting the Intrepid Sea Air Space Complex it was described as very difficult to get WiFi to work due the thick steel armour of the aircraft carrier blocking internet traffic and the ship itself being heritage listed. If presenting from outside the possibility of inclement weather can affect programming, especially in Alaska Zoo throughout the site and the Intrepid Sea Air Space Complex from the flight deck.

With a strong WiFi connection presenters can also now roam their site freely without a H.323 VC system with the introduction of new video conferencing options available such as Zoom, Field Trip Zoom, Polycom RealPresence, Cisco Jabber, Blackboard Collaborate, Safari Montage Live! and others as mentioned previously.

The Alaska Zoo, the Alaska SeaLife Centre and the New York Hall of Science all presented in the public galleries, describing the experience as having two audiences (one remote and one on-site). This was not seen as a hinderance however and actually seemed to produce a ‘buzz’ within the room as the general public watched the proceedings with interest. If anything it showed the attending remote audience that they were really were experiencing the cultural institutions as they really are if you visited in person, adding to the realism of the presentation. Crowd management is important however, as in the case of the Alaska SeaLife Center the peak visitation occurs before 1:00pm as passengers from the cruise ships enter the galleries on mass.

Mounting lighting on the VC cart enhanced the visual image being transmitted, especially in the darkened areas of some of the exhibit halls. Having a high quality headset microphone and earpieces were seen as critical for those sites presenting VC amongst the public. Having a movable cart did not in any way reduce the quality of the lesson experience. The Alaska SeaLife Centre presentations for example had 2 movable trolleys on which typical VC equipment found in distance learning rooms was mounted such as a document camera, codec, DVD system, computer, monitor, 50x microscope and lighting.
In each case the movable VC unit needed to be placed so that a clear line of sight to subject matter was possible. A useful advantage of moveable VC was the ability to store the equipment easily away from the public.

**Video conference robots**

An interesting development was in the use of video conferencing robots. The New York Hall of Science uses a [VGO™ robot](#) as a way for remote learners to interact with summer science camps occurring within the galleries. The learner is able to log onto the robot and control its movement, effectively acting as an autonomous student. There are other models available too; a popular one in schools is the one from [Double Robotics™](#) that is effectively an iPad™ rolling on a small version of a Segway™. In both cases these VC robots have found uses in hospital systems for bed ridden patients to provide virtual mobility as well as in schools for remote students to participate in lessons. The remote site simply downloads an app and controls the robot from their location.

**Special case – VC Exhibits**

An interesting design for video conferencing rooms was that of the [SeaTrek Traveling exhibits](#) designed and run by Mote Marine Laboratory. Each exhibit can be hired by a library, museum or other similar site so that the public can learn more about marine biology. The addition of a rental SeaTrek exhibit comes with the option to connect with [SeaTrek Interactive](#) at Mote Marine Laboratory for VC programs.
Individual STEM VC lessons discussed

Incorporation of hands-on sections within a video conference was seen as absolutely critical for a successful science lesson via VC. The teaching strategies depend on the age of the student and the program content. As the variety of different approaches are quite broad across each site (some sites run over 30 programmes. I have included information below on just some of the presentations below that have not already been discussed that would be of interest.

Alaska SeaLife Centre

Apart from K to 12 programmes the Alaska SeaLife Centre also runs preschool sessions such as 'Who Lives where?' which was adapted from an elementary special education program. Students use stickers to place animals in habitat whilst following along with the lesson content from the galleries.

Nina Mason Pulliam Ecolab

Interesting work is done with NMPO Ecolab with the Riley Hospital for Children whereby they run a broadcast to many hospital beds at once. An issue identified was that the educator had to be careful to ensure that the lessons could be as interactive as possible without restricting access for very sick patients. The NMP Ecolab also runs many preschool programs eg. Me, Myself & I, which is designed to introduce both science and early IT outcomes. As per the Alaska Sealive Centre preschool workshops the lessons are no longer than 30 minutes and are mostly hand-on to keep the 3 to 5 year old children’s attention.

Nina Mason Pulliam Ecolab – On the grounds and in the lab

Cleveland Museum of Natural History

This museum has a large variety of STEM video conference lessons, even one that incorporates the bee keeping materials in Secret Life of Bees! One interesting presentation discussed was that on sexual health. Students have submitted raps in the past as part of a competition, one of which is now part of the high school content used for schools. Due to the nature of the content the VC lesson it was found that it is best run via involving the remote teacher to help co-teach the session. The remote teacher can take control of classroom management as well as become familiar the slide content prior to the session; this means that the teacher can then prime the students for the content who respond accordingly by anticipating the scenes to follow.

CMNH: Lice, lice baby student presentation

CMNH: Bee keeping materials shown via VC
Travelling exhibitions such as the Silk Road can be accommodated and scheduled to be used by schools as needed.

**East Central Ohio Educational Services Center**

Several STEM VC sessions were discussed:

- *Ocean commotion* aimed at K-2 classes focusing on species ecology. Activity sheets for students and live discussion with the presenter on a green screen.

- *Spooktakular Maths & Mammals* whereby a craft activity of students making bats for Halloween linked is linked with basic mathematics.

- *In all probability* focusing on learning fractions and probabilities with a presenter on a green screen and the students operating the screen via smart notebook.

- *A piece of pizza* whereby students see how agriculture is linked to food in the home, tracing the food from farm to dinner plate (part of an 8 part agriculture series).

- *Dairy Cows... an Udderly Mooooving Videoconference*: Combining maths and creative writing to investigate the dairy industry (part of the aforementioned 8 part agriculture series)

- Students are also taught how to use Inventor™ CAD software via both sites sharing desktop screens.

**Monroe #1 BOCES- Challenger Learning Center**

I was able to watch a session on *Astronauts: Living the Dream* where a major theme was to encourage students to engage in STEM to become an astronaut. During this session students were presented a series of interactive series of videos and photo stills via Chroma key. The students were given control of the conference to choose the videos they wished to watch. Content included food, the shuttle launch site and launch, astronaut training, microgravity, toilets, health, sleep, neutral buoyancy lab. A space shuttle tile burn demonstration was included in the session as well as the session being supported via students trying freeze dried astronaut food before the conference.

**Smithsonian National Air & Space Museum**

We discussed some of the presentations available for schools during my visit. They run a K to Year 2 program call *Dressed in Space* which looks at life support systems for astronauts using puppets. From the Wright Gallery, which holds the Wright brothers flyer, there are opportunities to run VC presentations with a focus upon discussions on forces in flight and wing design. SNASM also organises 4 downlinks per year from the International Space Station so students can ask questions of astronauts, organised through Sally Ride Science. Occasionally there are times where online conferences run over 4 to 6 hours, whereby expert speakers and presentations are organised on a rotating basis throughout the day.
International Spy Museum

This museum was quite unique in that the content was unlike any other site visited as its focus was on the activities of the CIA, FBI, KGB, MI-5, NSA and others. The VC lessons place an emphasis on STEM, critical thinking, awareness, situational analysis plus historical and contemporary perspectives. Importantly the programme is delivered with authenticity and uses pop culture references to have students engage with artefacts, articles and websites to increase literacy outcomes. Several VC programs were discussed:

- **School 101** which is all about espionage and why people do it plus a discussion on coding, dead drops, signals of espionage, surveillance plus the tools and skills needed to operate as an agent. The presenter uses power point to show artefacts, historical photos, and video clips to place the students in the story and challenge their spy skills. Ethical dilemmas as well as the history of spying and current new items are explored. Efforts are made to make the topic relevant to the student’s personal lives connecting the delicate balance between security and civil liberties plus includes a discussion about student use of social media and how much they keep secret.

- **Spy Science Operation STEM** where students become Technical Operations Officers at the CIA trying support an agent in the field. Students are faced with problems and they have to solve them using their knowledge to build a signalling device from LED lights, a battery, paperclip, and chewing gum.

- **Operation Code Cracker** challenges students to find a mole in their spy agency. They need to reveal codes and ciphers to lead them to their conclusion. Mathematics in code breaking plus cyber security covered in the VC as well as a historical discussion on the enigma machine.

- **Cuban Missile Crisis Simulation** has students become source analysts at the CIA in October 1962 as they analyse primary documents and U-2 photographs used to advise President Kennedy at various stages of the Crisis.

The Edward Snowden affair has heightened awareness of espionage; students are always interested in the implications of the case and therefore can be used as a learning hook.

Intrepid Sea Air Space Complex

Several VC presentations were discussed on my visit to this historic World War 2 aircraft carrier.

- **Take Flight** which follows the 4 basic forces in flight. The focus of this presentation also included hypothesis testing, predicting and discussions as students run the following experiments:
  a) Gravity with a ball drop and toy man with a parachute
  b) Balloon rocket
  c) Paper strip aerofoil construction

- **Island Hopping Campaign** which incorporates students navigating to a timeline and plotting the ships position on a map. There is a strong focus on landforms and political geography.
• Be Healthy in Space which looks at the Space Shuttle launch and the inherent technology required to allow successful survival in space. The food and nutrition for astronauts discussed are then related back to the students own consumption habits to examine healthy eating practices.

Mote Marine Laboratory

Images courtesy Mote Marine Laboratory

Mote Marine Laboratory provide an online content unit for the teacher that includes lesson plans with activities including Build a Manatee, Shark Journals, Edible Coral Polyps and more. Each year, they connect with marine science classes (grades 9-12) who may connect for between 4-6 programs throughout the school year. Typically this is done to introduce a topic or to have a culminating discussion on concepts they have been learning about during particular unit of work.

Mote Marine Laboratory also has an English class (grades 6-8) that connects each year to enhance fiction pieces they are reading that involve sharks via introducing non-fiction components to their lesson.

Centre for Puppetry Arts

In addition to the collaborative program Folding Up! Run with Texas A & M they offer science content fused with puppet building of spiders, butterflies, plants, the tropical rainforest and even a Corythosaurus hand puppet in their Dinosaurs program. The Centre for Puppetry Arts also once offered a full Artist in Residence program that spanned over 12 weeks where there were options to create a puppet show centred around a STEM theme. Kinaesthetic movement is heavily incorporated in lessons for students under Year 5 as well as songs, discussions and flash animation games.

Minnesota Historical Society

Whilst the Minnesota Historical Society is mainly a history teaching facility there are still opportunities to teach STEM content. Also known as History Live!, the educators run a program which incorporates discussing the use of the scientific method through the viewpoints of historical inventors from Minnesota. Also the design of implements by for example a buffalo shoulder blade hoe from Indian Nations. They also encourage role play whereby act out historical characters using .pdf cards sent out prior to the conference eg. fur traders, trappers or bankers.
Cleveland Museum of Art

The Cleveland Museum of Art mixes STEM and art curriculum outcomes by drawing on its own collections. Sometimes they depict materials on the green screen where as other times they use a document camera or main camera to focus close onto a held specimen. Available presentations include sessions on the water cycle, weather, rock cycle, origami and mathematics, tessellations and simple machines for primary audiences.

Mariners Museum

The Mariners Museum concentrates on content surrounding naval exploration. Teaching techniques employed during sessions include students creating craft, recreating a scenario or work through a handout activity with the students during the connection.

Royal Botanical Gardens (Ontario)

The Royal Botanical Gardens runs a variety of ecology based VC workshops which depict variety of relationships of fauna and flora. Some of the teaching strategies employed for younger students include student role plays where they become the insects eating or plants germinating, playing guessing games with poetry, drawing pictures together or completing student worksheets. For intermediate/senior students they often play a version of the show Jeopardy™ to review concepts and discover what they don’t know. Project-based learning is run over several weeks with a French program and the site is currently developing a project-based program with a school in Alberta.

HECTV

Higher Education Channel TV is a producer of education and arts television programming and as such has a large body of media from which to draw from during VC lessons. Some discussions around their VC lessons included:

- Science Behind where 3D glasses, experiments and surveys are sent ahead of the VC lesson so that they student can perform experiments prior to the connection and then report their results during the VC.

- Inside the Artist’s Studio where students present their work to the artists for review and critique.

- Constitution Day where they have classes prepare a video, poster, PowerPoint or other multimedia presentation on the topic and include these in the prep material and program.

- History in the First Person whereby material is sent to the classes to familiarize the students with the event or time under study and the students then discuss their findings during the VC connection.

Minnesota Zoo

The Minnesota Zoo uses a combination of discussion, group-participation in-program activities, and multimedia games created by Flash™ or PowerPoint™ based. Several cameras are positioned around the Zoo to view the animals interacting. A popular VC lesson is Engineering & Animals video conferences which can be run as a three-part series or one-off programs.

So, how can a learner find these great experiences in the first place? The next section looks at the various booking systems used by North American schools and other sites wanting educational content.
Collaborative programs

Collaborative programs are where VC multiple sites either share the teaching of a particular topic to others or that multiple sites share the same project resources to produce a superior outcome to a project produced by a single entity. The very nature of video conference systems to bridge multiple connections lends itself to the exciting possibility of collaborative programs between content providers, Universities, schools and more.

My work at Fizics Education has constantly been to find synergies with other organisations to produce educational content for students and in some cases have been very open ended; often they are simply limited by imagination and budget of the entities involved.

Centre for Interactive Learning and Collaboration

One of the collaborative programs found was the KC3 project described by Jan Zanetis at the Centre for Interactive Learning and Collaboration. Also known as Kids Creating Community Content, the KC3 project is a contest that has student teams from schools around the world researching a topic in their community and then producing a 30 – 45 minute videoconference program geared toward a specific audience to educate them on the topic. The idea is to encourage the use of video conferencing whilst letting students learn presenting and research skills. This project has previously won recognition by both the International Society for Technology in Education as well as from the United States Distance Learning Association.

Collaborations Around the Planet

Described as a social networking tool for educational videoconferencing, Collaborations Around the Planet (CAPspace) allows schools interested in collaborative videoconference projects to find each other and work together on shared VC projects and presentations. CAPspace also provides registration for collaborative events and projects such as Two Way Interactive Connections in Education (TWICE) Read Around the Planet. There are currently 14348 educators from 56 countries registered with CAPspace.

Center for Puppetry Arts

A four year collaboration with the Center of Puppetry Arts and Texas A & M University through the National Science Foundation is currently underway. Here they offer an interactive puppet show entitled, “Folding Up! A STEM-based Puppet Show!” for grades 2nd-4th. This performance was written and is performed by Dr. Gregg van Laningham (PhD in Materials Science, Georgia Tech) who is also a puppeteer. It teaches about STEM careers, specifically Aeronautics, Materials Science and The Scientific Method as told by characters in Origami Town. The narrative specifically focuses on the character “Aggie” who is a piece of origami paper that isn’t sure what she wants to be when she grows up (though they say “folds up”). Through a recorded field trip to Texas A & M University, a visit with a female graduate student plus help from a few other origami characters, Aggie learns about different STEM career options and how the use of The Scientific Method can help to solve everyday questions.

http://vimeo.com/58118219
http://vimeo.com/63823151

Center for Puppetry Arts – South Carolina students involved in Folding Up!
Mariners Museum

The Mariners Museum was involved in an interesting collaboration with Amateur Radio on the International Space Station (ARISS) to make a connection with the International Space Station. Here they used a bridging system to connect several schools from New York State, Louisiana, and Indiana along with students in the Mariner Museum VC room to speak with an astronaut aboard the Space Station. As described by Ann Maree Millar "It was a symphony of various 'older' and new forms of communication!" It was arranged by used video conferencing to bring all of the students into the Mariner Museum's studio where then they used a phone to talk to the radio operator in Italy who served as a "telebridge" to the International Space Station via short wave radio. To expand this session there was a follow on VC program which drew comparisons between the Age of Exploration during the 15 - 18th centuries and exploration today.

Aquarium of Pacific

The Aquarium of the Pacific has produced a collaborative pilot VC which brings together onsite educators, shark biologists and robotics specialists for students to see possible future career paths in science. Future programs are likely to be run on the strength of feedback received.

Monroe #1 BOCES

The team at Monroe #1 BOCES have worked with Georgia Aquarium to co-present education on whale sharks in their large aquarium while diving as a series of multisite conferences.

Smithsonian National Air & Space Museum

The Smithsonian National Air & Space Museum has run collaborative science programs with the Seattle Museum of Flight on the Wright brothers' flight program. Additionally the Duke Ellington Charter school students were trained to help present STEM30, whereby short 30 minutes sessions are run with schools who perform simple science experiments within their rooms supported by demonstrations in the museum. The SNASM has also run collaborative sessions on World War 1 with the Royal Air Force Museum in London.

New York Hall of Science

NYSCI has worked with senior citizens in retirement homes via a collaboration with Selfhelp Community Services, Inc. They have also run connections with chronically-ill students in hospitals and homebound students using multipoint connections in collaboration with Living Through Learning Foundation in the District 75 school jurisdiction. They have also worked in collaboration Ann Arbor Hands-On Museum on a digital learning day.

Mote Marine Laboratory

A great example of mutual benefit is whereby Mote Marine Laboratory has worked with Columbus Zoo to both teach each other’s home school audience. In this case the arrangement involves the costs being reciprocated evenly across all the sites. They have also been involved in a multi-year project based learning program with the New York Institute of Technology to work with schools in New York. They used the feedback from the schools to develop a new K-2 program on dolphins.
Intrepid Sea Air Space Complex

The Intrepid Sea Air Space Complex was involved in program funded by Institute of Museum and Library Services (IMLS) in collaboration with Educators Enterprise Zone (EEZ) and New York Institute of Technology, Central Islip campus. In this collaboration a 12 organisations work together including New York Hall of Science, Mote Marine Laboratory, Crystal Bridges Museum of American Art, Birmingham Museum of Art, Fire Island Lighthouse, Baseball Hall of Fame and Museum of Fine Arts Boston to work in a STEM advisory team involved in EEZ summer program which is hosted by Blackboard Collaborate and Safari Montage LIVE!. Here the advisory team VC content providers are paired with classroom teachers to produce a unit of work that are run via VC and are then presented back to the main group as case studies. Lessons were to align with the curriculum of the school as well as recently adopted Common Core Learning Standards.

On my visit to Intrepid a couple of these collaborative units of work was discussed in detail:

**Collaborative work 1**

Intrepid Sea Air Space Complex was partnered with a Year 3 New Hartford, New York computing teacher to produce a unit of work that focussed on:

a) Businesses that support an aircraft carrier.
b) Similar business and operations found in New Hartford that can also be found on Intrepid (eg. doctors, painters, mechanics etc).
c) Community relationships between Intrepid and the mainland.
d) Geography on where Intrepid had been, requiring a map to be constructed with timelines.
e) Discussion on the Mediterranean shore visits and the creation of informal badges by the local seamstresses for different naval units. The participating students created their own badges digitally and shared via VC.

The produced work at New Hartford was required to be presented by students back to Intrepid Museum as a research report.

**Collaborative work 2**

Intrepid Sea Air Space Complex educators were partnered with a Year 10 & 12 Latin teacher. The unit of work mirrored the Gallic Wars with World War II and Vietnam whereby students:

a) Viewed photos of intrepid throughout the its campaigns; dry dock, created blood chit, sailor shore time activities, the Panama canal crossing, Kamikaze strikes on the ship and more.
b) Viewed 1st hand artefacts such as Action Reports, Diary Entries, Night Orders etc.
c) The above was used as evidence for the students to act as historical researcher to put together pieces of the puzzle and then collaborate together to produce a final history which was presented via VC back to Intrepid.

Apart from historical evidence the unit of work also looked at the requirements of citizenship and duty to sovereign nations.

**Ann Arbor Hands-on Museum**

The Ann Arbor Hands-on Museum runs three programs whereby educators from the Leslie Science and Nature Center use their studio due to lack of VC at their own site. During these VC connections the Leslie Science and Nature Center educators bring live animals into the VC studio and co-produce animal based collaborative programs with the museum. This allows the Ann Arbor Hands-On museum to enhance their programs with live animals which they do not have plus it has greatly helps the Leslie Science and Nature Centre reach a much wider audience.
Royal Botanic Gardens

The Royal Botanic Gardens has worked with the Canadian Aviation Museum in Ottawa when they had a temporary butterfly exhibit at their location. Here the botanic gardens did a presentation on the ecology of butterflies and moths and the museum run content based on flight mechanisms in the insects. Such a collaboration allowed expertise from both biology and physics professions to create a richer VC presentation. They have also worked with a number of environmental organizations in Canada on VC presentations on particular ecosystems local to their area. This was seen as an excellent opportunity to see the similarities and differences amongst the huge variety of ecosystems across Canada by the students and teachers.

They also bring in VC presentations for the public by E.O. Wilson, Richard Louv, Amy Stewart and California Carnivorous Plants as well as other content provider programs that support and add value to special winter exhibits.

Higher Education Channel TV

HECTV worked with Pearl Harbor Museum on the 70th anniversary of the Japanese attack. There are several military and civilian survivors who live there and work with the Museum. Students got to hear first-hand from the survivors what it was like in 1941.

Minnesota Zoo

Sharing information between sites can broaden the programs delivered by a content provider. After Galen Sjostrom from Minnesota Zoo travelled to Taiwan to work with the Taiwan Black Bear Conservation Association he has been working on a pilot “Here & There Bears” program to be released soon. The VC will draw upon information shared plus video and photo resources to highlight the similarities and differences between Asiatic and North American black bears while at the same time teaching some basic Chinese language skills.

Case Study: School District Support of VC

The Central New York Regional Information Center (CNYRIC) serves 50 school districts and four Boards of Cooperative Educational Services (BOCES) across eight counties in the central region of New York State. There are three primary divisions: Instructional Technology, Student Services, and Operations. Services include everything from professional development for technology integration, to student management systems, to network infrastructure equipment and planning plus provision of digital content and maintenance of a high speed Wide Area Network (WAN).

Video conferencing support options available through CNYRIC

- CYNRIC acts as a consultant to schools to provide full teacher PD support in terms of hardware procurement, establishment and setting up connectivity in schools. CYNRIC also provides training in VC system use for teachers and where to find VC opportunities.

- CYNRIC offers timetabled programs supported by an MCU server bridge and phone support in a 3:1 multipoint conference whereby high school students can gain credit for college level courses. Each BOCES supports school district for establishment of these courses.

Advantages of school VC use

a) Used to support lack of funding for specialist teachers or lack of specialist teacher certification for on-site teaching of formal coursework (eg. Advance Placement Physics).

b) Dependent on identified school poverty levels the program is supported financially up to 75% through State Aid as a reimbursement for running enrichment courses within their school.

c) Helps prepare remote science students for required lab work so that when they do attend the lab the time is shorter and more productive.
• Links classroom teachers to a large database of content providers and teachers & helps in selection of appropriate content aligned to Common Core Standards.

• Supports teachers in Mega conferences via http://123vc.pbworks.com/w/page/716971/Home Involved sites are CNYRIC, ESC Region 11 - Fort Worth & i2i Technologies. A week filled with workshops on using VC are conducted in a variety of exchange projects, academic challenges, mystery quests and A.S.K. Teachers are challenged to produce shared content between classes and across key learning areas.

Example of a collaboration that arose from 123vc

3 classes in different locations and key learning areas all contributed to a collaborative piece of work.

a) The science class first runs an acid/base workshop to dye cloth material in New York.

b) This material is sent to a Mathematics class in another school who uses the dyed cloth to produce tessellations and geometric designs.

c) The cloth designs are then sent to a French class in New York that copied these geometric designs for use in mud painting related to French storytelling.

d) All the classes communicated via VC about what they were doing in each stage of the process.

• Supports flipped learning implementation in classes.

Case Study 1
An American Sign Language Teacher employed by CNYRIC records her presentations on a Tandberg Content Server which can be viewed by distance students across 7 school districts in her absence. VC is then used to work with the offsite learners to build upon viewed videos.

Case study 2
A high school Physics teacher approached CNYRIC in April 2013 about how to flip classroom using his own produced videos of experiments for Physics and Environmental classes. Using http://www.screencast-o-matic.com/ he has setup a YouTube channel for students to watch in their own time so that his classroom can concentrate on experiments that prove Theories. Now classroom has become completely paperless and is hosted via apps supported through Google Drive and Edmodo blogging (all students year 9 to 12 have iPad minis). Offered to remote learners.

• Collaborates with similar sites such as Berrien Resa for student outcomes.

Future directions for CYNRIC

• Very interested in working with iSee via Smart CRC Wollongong in collaboration with Australian Independent Schools.

• Incorporating LOTE during the next 123VC conference

• We discussed Virtual Sumer Camps offered through Google + by Exploratorium. Up to 9 student sites are given maker design challenges to take back to class and then they report back with results to each other and the public can login and watch the conversation.
Accessing video conferencing content

There are several platforms designed to list video conferencing experiences for the general community to access in North America. Australian sites can use these systems to find experiences suitable for their needs, as well as access Australian VC experiences through Virtual Excursions Australia, NSW Distance & Rural Technologies, See Share Shape and the Victorian Virtual Learning Project. The following details the major platforms discussed during the fellowship tour that are regularly used by North American VC content providers to list VC STEM lessons.

Center for Interactive Learning & Collaboration.

The majority of the virtual excursions listed and booked in North America arise from the Center for Interactive Learning & Collaboration (CILC). Formed in 1994 in Indianapolis, this non-profit entity connects schools, retirement homes, libraries and more to high quality video conference experiences from across the globe. CILC acts a hub for schools to search through hundreds of video conference workshops offered by over 230 VC content providers. The VC experiences listed by content providers within the CILC website are publicly rated by the remote sites that book the content. As mentioned by Ms Jan Zanetis at CILC the public rating system places a strong incentive for content providers to produce VC lessons of strong educational value; for the past 7 years the best content providers have received Pinnacle Awards which is an award to those CILC content providers who have run more than 10 workshops in a year and have had an average score for all program evaluations over a year of 2.85 or higher out of a possible 3 (an individual program receives a star rating if it averages a 2.4 or higher). The CILC program evaluation assesses seven questions which drive the star rating and CILC Pinnacle Award:

The presenter:
...was knowledgeable about the content.
...was engaging.

The program:
...was engaging.
...was appropriate for the advertised age/grade range.
...aligned to the advertised educational standards.
...met the advertised educational objectives.
...had an impact on student learning.

Listing content on CILC is very straightforward. All VC content providers can request access to join the CILC website and pay a small fee to join. Once a content provider is accepted onto the site the process of listing a particular workshop is straightforward:

- List the name of the session and brief description.
- List the full description, including the way the lesson will flow.
- List vocabulary used within the session and any required pre-reading or coursework.
- Align the content to State or National Standards in the USA.
- Note the price of the session and whether it can be booked singularly or part of a module of sessions.
- List any cancellation notes plus required equipment and bandwidth that remote sites should have
- Finally upload supporting pre-workshop, during workshop and post-workshop material.

As the CILC lists the option for sessions to be booked ‘by request’ it is easy to simply list sessions for classes so that teachers can place it into their school schedule. You can also place a specific date and time offering of a particular program into the CILC calendar however this may not attract as much attention as it is quite inflexible for teachers to be locked to particular day compared to sessions they can book ‘by request’. As long as evaluation forms received from teachers are satisfactory the content provider can continue to list sessions with CILC.

A massive advantage of this booking system is that schools book programmes in their own time zone and requests are converted to the VC content provider’s time zone. My own company Fizzics Education has been running workshops through the CILC site for several years and is quite used to receiving requests to run sessions at 4:00am due to the time zone differences to the USA! Using a time zone converter to work with the remote site iron out any scheduling difficulties.
Additionally CILC lists collaborations whereby schools or others can list a particular need to connect with another school with a similar class. For example, a school class might want to connect with another class who is studying marine biology so that the two classes can present project together. The site also lists professional development sessions that are available for schools to learn either specifically about video conferencing or about a particular key learning area. As mentioned by Ms Tonia Carriger there are a number of professional development workshops available for teachers to access either on a particular content area or on video conferencing itself.

Schools have the ability to use the CILC content dollar bank whereby a school administrator can simply pay a lump sum of money into their school account with CILC from which teacher’s book sessions. This means that schools can work to a particular budget of video conferencing each year and teachers don’t have to continually ask parents for money each time a VC class is required (a barrier often cited by teachers).

In practice schools login in to the CILC site to view and book programs through a created school account. Generally once a particular session is booked the process involves;

- The remote site receiving pre/during/post work to support content.
- Some programs have materials mailed out to the teacher prior by the provider (eg. Test tubes).
- Arranging a connectivity test call prior to the scheduled date.
- Then content provider education team provides the technical support and delivery.
- On the booking day it is accepted that most sites should call in 10 minutes prior to the session.
- Sessions vary but generally run for 60 minutes but shorter for younger ages.
- Once the VC class is concluded the teacher then fills out an evaluation form against the workshop which is shared with both CILC and the content provider.

There was some indication from VC providers that school bookings are declining for some content providers whereas for others the bookings were remaining steady. Further research into this would be interesting to see why.

Twice.cc

Two Way Interactive Connections in Education (TWICE) is Michigan’s organization for videoconferencing in K-12 education. A database that contains educational programs (k-16) from content providers, such as zoos and museums that offer participation through IP-based videoconferencing. There is a simple search function for programs within the website as well as a large resource section that includes case studies, articles, research related to video conferencing as well as associated links to help teachers find out relevant information to get VC running successfully. Additionally there are links to the CAPspace project mentioned previously. The program also reminds educators of the professional development opportunities available in video conferencing run by content providers listed on the CILC webpage.

Senior Learning Network (seniorlearningnetwork.com)

The Senior Learning Network (SLN) is a relatively new website distinctly designed to provide a window for senior citizens use of video conferencing either from a retirement home or from a private residence to access education providers. It runs via membership from retirees and senior communities looking for lifelong learning and social interaction. A calendar of events is available as well as professional development opportunities for those involved in aged care.

Berrien Regional Education Services Agency

Berrien Regional Education Services Agency (Berrien RESA) is an education service agency serving 26,000 students in Berrien County, Michigan. It offers many services for a large number of schools but amongst this the Instructional Technology Department arranges professional development in information technology and video conferencing coordination for teachers in the classroom.
Digital Human Library

The Digital Human Library (dHL) is aimed to provide Canadian teachers and librarians with links to organizations running curriculum-based programs using video conferencing technology. There is also a section which details some of the video conferencing platforms available as well as multimedia virtual tours around the world.

Google Connected Classrooms

A variety of educational experiences are listed by Google Connected Classrooms™ which uses Google Hangouts™ as the backbone for the experience. Hangouts on air are broadcast from and saved to the owner’s YouTube™ account for access by the users at a later date.

Skype in the classroom

Skype in the Classroom™ is similar to Google Connected Classrooms™ only uses the Skype™ platform for virtual education delivery.

Education Plus

Education Plus is a non-profit educational service agency that brings school districts together to share resources, information and ideas. The St. Louis Regional Professional Development Center operates under contract with Education Plus and combines Education Plus staff development resources with Missouri Department of Elementary and Secondary Education resources. It runs a blog called the Connected Classroom which lists video conferencing events and professional development opportunities.

New York Educational Enterprise Zone

The New York Educational Enterprise Zone lists content providers who run video conferences.

Costs of virtual excursions

Pricing educational services is a subject that can be controversial in VC education but doesn’t need to be. All of the content providers visited offered opportunities for schools to attend free VC sessions and often arranged special discounts for small groups that could not pay full price due to lack of funds. For the programs collecting fees most prices ranged from $30 to $150 for 1:1 connections, i.e. just one school and the provider. For multipoint connections there was often a reduced fee and schools booking through CILC could receive discounts via having premium accounts.

By necessity of VC production quality the visited content providers all used specialised H.323 equipment usually in a dedicated distance learning room. Considering the costs of establishing a VC room, the associated internet costs, the staffing costs, the administration costs, the advertising costs and training necessary to become an expert in a given field it is amazing just how cost effective a virtual excursion really is, especially when compared against the cost of getting buses and accommodation to a site (let alone entry fees to a particular exhibit or cultural institution).

In some cases a particular site winning a grant or receiving corporate sponsorship can reduce the costs of a VC to the consumer to zero over a long time period, which has raised concerns by some content providers that the consistent delivery of free VC content by some sites might produce an unsustainable benchmark in the long term. Some steps for further collaboration and pooling of resources between providers have been taken but are still in their infancy.
Challenges for STEM VC

Challenges for VC content providers

Whilst there have been tremendous successes in delivery of VC educational content there still remains a number of shared concerns that the interviewed VC content providers described, in some cases almost word for word. The following details the main issues;

- Funding for capital purchase and subsequent onsite development and delivery can be very challenging. Costs can be considerable to initially establish a formal H.323 distance learning space and then train education staff to design and present educational content via VC effectively. Despite this content providers know that there is a strong need to have up to date H.323 VC equipment to produce world class content and remain relevant to consumers.

- Even though some of the providers receive some form of backing, whether from a donor, sponsor or from specific government funding their operation costs still in most cases outstrip the costs of VC implementation and delivery. There is constant pressure to keep costs down for the consumers, even to the point of it being unviable to continue if funding support was removed. This could be improved with more remote sites connecting to these content providers to make the systems more viable.

- Internal support can be challenging for some sites as a fully-fledged distance learning room requires dedicated space and IT support that may not be available. The approval processes within some institutions are slow to take on new VC equipment and staff. In one case this meant that the provider missed a funding round that required co-contribution of funds from the institution.

- There may be a need to share a distance learning studio with internal programs which affects how often a VC program can be offered. Also in most cases the education staff do more than just run video conferencing sessions, they have to squeeze VC sessions in-between on-site program needs such as visiting school classes, scout programs, overnight museum stays, administrative requirements as well as curriculum development and exhibition development.

- Unfortunately in a few cases the internal culture and education focus of the cultural institution may not appreciate the value of video conferencing in terms of profile exposure of the institution to schools and as an additional avenue to add value to traditional outreach and incursion initiatives. Internal communications of VC program successes for upper management buy in is seen as needed in these cases.

- Getting content to new areas such as libraries, retirement homes, juvenile justice sites, camping, scouting groups and more is always a challenge in terms of finding decision makers. Marketing of programs is always on a limited budget. Reaching schools and other sites without the H.323 equipment is now no longer an issue however as there are many cloud based versions of H.323 conferencing available. Communicating this to teachers, librarians, retirement homes and more is now the focus of marketing efforts.

- Communication channels between school decision makers and STEM VC content providers are fragmented and isolated.

- The capabilities of the end user to use H.323 VC systems and interactive BYOD options can limit particular program; the VC lesson could be more interactive but the receiving site requires a lot of training to get them up to speed. A few VC content providers noted that in a number of cases the remote site had simply not read the required pre-VC preparation and as such had not brought in the materials required to make the VC more interactive. Every content provider interviewed offers professional development lessons to some degree to mitigate the issue. Busy school schedules can cause a scheduling mistake or a missed opportunity for students to do background preparatory work prior to the conference commencing. Also when working with hospital schedules the operations and doctor visits can cause last minute changes.

- In some cases the cultural institution has needed to run basic training to the remote site on how to operate a particular system. It is important that during professional development delivery users learn
about the limitations of the particular equipment and software options in terms of firewalls and hardware/software meshing. Importantly it was suggested by some that the staff development process should incorporate booking scheduled events with VC content providers who are well experienced in handling the various systems and so that various teachers, librarians and more could see how a VC program is interactive and worth incorporating in any sequence of learning.

- The limitation of time tabling to other time zones limits the abilities of VC content providers to reach more learners. Depending on the site some cultural intuitions cannot operate after hours due to security needing to lock the building or needing to put in for over-time approval to run sessions after 6:00pm local time – frowned upon at some sites.

- VC content providers also wished to be able to schedule special events with curators or collaborative programmes with other sites but this can be limited due to the difficulty of getting the program to fit all of the shared schedules. This can cause a restrictive booking window for schools which means the program may not to be taken up as the schedule can be quite inflexible to change to fit a particular school’s needs. Several VC content providers lament this as a missed opportunity to provide rich content for learners.

- There may also be internal firewall issues that hinder the establishment of video conferencing at both the cultural site and the remote site. Wi-Fi connectivity within a cultural institution must be strong to allow for a roving video conference trolley.

Nearly all VC content providers would like more reliable and consistent network infrastructure. The VC industry’s Achilles’ heel remains the poor internet connection quality in some areas which leads to low picture resolution, distracting audio delays and more. Once schools have received a poor VC service due to restricted data they have been known to blame the content provider who has no control over the issue and worse may not ever try a video conference again. It was interesting to find out that the E-rate program currently overseen by the Obama administration has a direction to get high-speed internet to 99% schools in the USA. Speeds of 1Gbps per 1000 students/teachers for a school’s external connection to an internet service provider and an internal Wide Area Network (WAN) of 10Gbps per 1000 students/teachers by 2018 are planned. At a cost of $US 2.3 billion it is a considerable rollout that could alleviate many concerns raised by VC content providers however many delegates at the 2014 ISTE conference suggest that this should be raised to $US 5 billion to allow for the proliferation of smart tablets in schools which each require internet connectivity to function properly. Increasing broadband speeds at schools makes sense as the internet is the backbone of modern society of which video conferencing is a part; whilst a VC presentation can run at 256kbps the reality is that the experience of the user is poor due to grainy picture and higher possibility of screen freezes and call drop outs... higher bandwidth means better experience.

Even the cultural institution site itself presents challenges. Seasonality of sunlight affects programming in the Alaska SeaLife Center which sometimes opens at 10:00am due to light levels as well as difficulties for educators reaching the site to present sessions due to road closures from ice on the roads. The centre plans on running VC within their rehabilitation centre which will introduce quarantine issues around planning, meaning that an educator needs to allow for decontamination procedures following a presentation which takes additional time. Sometimes there is nothing you can do; the Intrepid Sea Air Space Complex was heavily affected by Hurricane Sandy damaged which damaged the Port and there was no power for 2 months.

In an ideal scenario the VC systems should have interoperability between devices, the technology be standardized, that global internet bandwidth was raised for all schools and both the VC content provider and schools consuming the experiences have government support in terms of ongoing funding, technology support and in education for use. Most importantly the largest requirement of VC content providers was that it is essential for all educators to know that video conferencing exists, understand how to use it and that it can be incorporated into a standard teaching regime. Simply put, the biggest hurdle is public understanding of the technology and understanding its value.
Challenges for schools and other remote sites

The challenges for educational video conferencing lie not in the current available delivery methods or the actual content being transmitted but rather in getting remote sites to adopt the technology. Despite large number of schools, libraries and other sites connecting to VC content providers research by the Center for Interactive Learning & Collaboration and Wainhouse Research has found that less than 5% of school in the USA have engaged the services consistently. The main barriers cited by this research are:

1) Internet access.
2) Cost of H.323 VC system implementation.
3) Ease of use of installed H.323 systems.

Internet access was cited as by far the biggest issue facing connecting to schools. If a video conference images freezes, the audio fails or the VC call drops out completely due to poor bandwidth it erodes teacher confidence in using the technology at all. The raise in the E-Rate cap mentioned previously will do much to help sites that have poor internet access. Additionally if a school wants to put in H.323 equipment they need to apply for funding internally which may not exist or even if the funding does exist the merits of the technology will be debated for much longer than necessary. Once installed H.323 systems require some training to get educators familiar with how to use it. Unfortunately in some cases the training has not been sufficient in either quality or duration. The issue still remains that there needs to be time to allocate professional development in H.323 VC system use in sites where they are already established; teachers are time poor at the best of times and as scheduling in support mechanisms and dedicated training times would help immensely. One-off training days are not sufficient; constant use breeds proficiency. Thankfully all three of these barriers have been largely mitigated with many schools now having broadband internet at a reasonable cost that can take advantage of the advent of easily used cloud-based web conferencing services that link to H.323 systems that use low bandwidth. If joining a STEM VC just requires a click on a hyperlink and the platform is easy to use the need for intense training is removed and as a result people will use it more.

Funding to access video conference events that have a charge, even if it is small is difficult in some areas. Several times it was commented that the low funding levels of some schools meant that some teachers were beginning to opt to only have 1 class be in a live video conference and that the other students got to watch the conference either from a recording or as a “live” connection in another room - a poor way to experience a live experience. Some schools and sites are in low socioeconomic areas that can only consume free video conferences as parents cannot pay even the $2 it may cost for their child to participate. Funding for these areas is critical to provide universal student access to educational opportunities. School district funding is known to have diminished at some sites.

Duration of the video conference experiences were also cited as an issue for some teachers mainly due to attention spans and strict school bell times for the day schedule. Most content providers are opting to offer sessions ‘by request’ to avoid the school timetable issues; especially important when trying to fit a video conference into a busy high school timetable. Generally most content providers sessions should be able to fit into a school schedule as they mostly are between 30 minutes and 45 minutes long for elementary school students and between 45 minutes and 60 minutes for older students. Extended sessions of over an hour can use school lunch breaks for the students to refresh and then call into the conference later on.

The general feedback received by VC content providers is that the requirements to meet state and federal education standards in a cluttered school timetable discourages teachers from giving over too much of their class time (even for a 1 hour session) to outside presenters when studying a specific unit. If enrichment programs are not perceived as directly related to a specific curriculum outcome then it is more difficult for teachers to justify using that VC experience. USA schools are now moving towards the Next Generation Science Standards which means that content providers will need to align their sessions to these curriculum outcomes as well.

I also heard feedback that schools are sometimes only allocated 1 excursion per school term and therefore would rather use that 1 excursion allocation on a bus trip to a site rather than 1 virtual excursion. Considering that the costs of virtual excursions are often less than 1/10 the cost of bus hire and that up to 5 lessons from different VC providers could be done over the same time of a single day trip outside school this is unfortunate. Based on this it would have been thought reasonable to allocate at least one of the school terms to using 21st century technology to best leverage funding, class time and learning opportunities.
Future directions of VC content providers

Common directions

All the VC content providers indicated a willingness to expand programming to reach more hospitals and retirement homes. Both young and old audiences love the content and definitely benefit from the cultural exchange let alone the science content. Those running hospital programs will continue to be refine them so that they can be interactive with materials that are safe and accessible for a variety of patients to use. School and library programming will continue to be a priority for VC delivery, with some looking to expand to other markets such as the home, clubs and associations where there may be a need for educational VC content. Some VC content providers mentioned the International Association for K to 12 Online Learning for reaching more school audiences. Several were interested to expand their VC programs to include Members Nights and teen or adult programing as well as to collaborate with other content providers. Regardless of audience, all of the content providers visited have the capacity for at least twice the connections currently made.

There is room for North American video conferencing to expand, especially across borders and into different time zones. Securing funding to deliver programmes continues to be on the minds of Directors and Managers of distance learning services at each visited location. Creating a palatable model that attracts either corporate sponsorship or charitable benefactors is seen as a high priority.

The emergence of BYOD website & social media integration into video conferencing is a tremendous opportunity. The example of BYOD implementation shown at the ISTE conference by Minnesota Historical Society clearly showed promise for all content providers who attended. On speaking with many museum educators there will now be a move to put BYOD into programs as an engagement tool, especially for marginalised remote learners.

The following details intentions for future development of VC by the content providers not already mentioned as well as a few noteworthy uses of VC rooms.

NMP Ecolab

The NMP Ecolab leases their video conference room to 4 local content providers at a low cost (a drummer/storyteller, an author and two historical character actors).

Royal Tyrrell

Home school programmes to Alberta associations are being launched in 14/15 school year. The tutorial-based programmes will be run as a multi-point to 3 sites and delivered by 1 presenter in modules. Interest has already been shown by families to participate.

Alaska SeaLife Centre

Coming soon will be the multi-purposing of new VC equipment to be installed in their rehabilitation centre for remote sites to view animals such as spotted seal and walrus. This will not just be used for school teaching purposes, it will also be used to teach veterinary care with remote technicians.

Smithsonian National Air & Space Musuem

There are a variety of planned video conferences in the pipeline:

- World Space Week 2014 VC’s concentrating on navigation. Earth Day programs also a possibility.
- Speaking with presenters in the Neutral Buoyancy Lab in Houston including discussions with astronauts on a monthly basis.
- Commencing teacher professional development in partnership with Ball State University. Teachers will get credit for accreditation the sessions will be supported by a MOOC.
- Video conferences around their 25th anniversary celebrations.
- Possibility of a video conference built around new Orion spacecraft or the New Horizons Pluto-Kuiper Belt Mission scheduled to arrive at Pluto in 2015
The New York Hall of Science is looking to applying iOS based science-apps into video conferencing to simulate a high school science lab environment for hospital/homebound students. Designing a program around Minecraft was also seen as a possible future program.

Future predictions of VC delivery

Content providers have adapted onsite and outreach workshops to suit video conferencing and now are developing content specifically designed for the video conferencing medium. During the trip I asked content providers about their thoughts on where educational video conferencing might lead to. The following lists some of their thoughts:

- H.323 conferencing units will continue to be needed for immersive distance learning rooms as they bring a high production quality to the VC experience. However, they will be paired with web-based conferencing solutions that use cloud hosting to reach further audiences at remote sites who are in low bandwidth areas or do not have H.323 VC systems.

- As public awareness and ease-of-use of web-based conferencing public awareness increases more cultural organizations will experiment with outreach via interactive video which effectively means more competition for existing content providers. This in turn will apply continued downward pressure on program fees for schools who connect to video conference content providers. Content providers, software/hardware vendors and internet service providers will work together more to deliver tailored packages to suit different audiences.

- High-speed wireless and mobile technology will make it easier to broadcast from areas that would be unreasonable or inaccessible with wired connectivity. BYOD in schools and other sites will become common place and flipped learning plus learner self-direction will drive the development of more VC programs that will suit learner needs as an individual.

- Technical expertise will be of less importance for the day-to-day operation of VC technology. Over time it will be no more remarkable to be in a VC than making a telephone call. At this point it will be the teaching pedagogy that drives better STEM teaching via VC rather than the tool itself. Autonomous video drones will make it easier to acquire live video from unique perspectives.

- Universities will require pre-service teachers to complete units of work around video conferencing to prepare for school deployment as it will be seen as a common place tool for teaching rather than a fringe skill.

- The proliferation of reliably high-speed internet connections across the world will continue to grow and with that the infrastructure for high-quality, smooth video conferencing will become an expected norm.

An interesting perspective was given by Mr Galen Sjostrom of Minnesota Zoo where he suggest that an iterative jump in mobile technology is still needed before we see VC supplant (or even approach) the popularity of text and voice communication. Even though front-facing cameras are now ubiquitous in smartphones and tablets, VC remains an infrequently-utilized feature compared to device sales despite ongoing promotion of applications like Google Hangouts™ and Skype™.
CONCLUSIONS AND RECOMMENDATIONS

It is almost impossible to put into words the enormous gratitude I have for having been given the opportunity to complete a Winston Churchill Fellowship. After a whirlwind trip across 16 sites in 7 weeks I learnt a lot about how to teach STEM to audiences in any location using a variety of video conferencing technologies and software solutions. The depth of knowledge, dedication and generosity shared by the visited sites was tremendous and in many ways an overview report cannot do justice to describe the huge variety of STEM video conferencing workshops and their subsequent student impacts delivered everyday by these content providers to learners.

Video conferencing remains the most effective way that learners can engage in real time with celebrated scientists, view unique science demonstrations, collaborate between sites and be guided by STEM experts to run hands-on science experiments in any location. No longer do learners have to spend large sums of money to travel to a particular museum or cultural site to get an authentic STEM experience. Additionally the medium encourages critical thinking and communication skills in a 21st century environment that it is being rapidly adopted by the collaborative workplace. Schools, retirement centres, libraries and more can use the technology via either a formal H.323 video conference system or a computer or smart device with ease.

Despite strong gains in delivering to a wide audience over the past 20 years the technology remains a fringe part of teaching and understanding of its ability to change lives remains poor. I encourage everyone involved in educational video conferencing to work with their respective organisations and associations to encourage the use of best teaching practices and to embed the use of the VC technology into everyday teaching pedagogy. The following details the major learnings taken from the fellowship tour!

- Teaching STEM via VC should be an interactive and immersive experience; make it fun and make it real! Wherever possible remote learners should have experiments to run at their site to make the connection interactive and content providers can enhance their lessons by offering access to in-house experts and equipment not normally available at the connected locality. When hands-on experiments are combined with multimedia presentations, BYOD, songs, kinaesthetic activities and deep discussions on content a great hands-on STEM VC lesson turns into a fantastic event that has the potential to change the direction of student’s lives. If the VC lesson is being directed to K-12 learners it will help the teacher’s if the relevant curriculum links are stated so that they can book the session with confidence.

- Collaboration on successful teaching techniques between content providers, libraries, schools and more needs to be encouraged wherever possible. Every content provider wished for a stronger collegiate atmosphere between all users; both from a production side and the remote user side. Content production should not be done in silos as innovation can stagnate and the remote learner does not get the best possible experience. Let’s work together!

- Professional development of remote users is critical, both at remote sites with H.323 equipment and in Universities prior to teacher employment. In the 21st century educators need to be equipped to teach using collaborative technologies so that students don’t miss out on the fantastic STEM learning experiences available, as well as to prepare learners for workplace. Expertise from experienced VC content providers should be sought by Universities, schools, libraries and more wherever possible; their knowledge on best practice in STEM VC teaching comes through hundreds of lessons which have been evaluated constantly by peers over many years. Time should be made to understand how to use the technology effectively through professional development and simply using the systems already installed.

- Content providers should continually update their VC presenting skills and wherever possible update their equipment when the budget is available. Web conferencing options such as Zoom™, Field Trip Zoom™, Polycom Realpresence™, Cisco Jabber™, Google Hangouts™, Skype™, Safari Montage Live!™, Blackboard Collaborate™ and more offer the possibility to reach any learner on the globe with an internet connection, even ones with low bandwidth. The current technological landscape offers a tremendous opportunity to expand STEM education and cultural exchange – no learner should miss out!

- Whilst K-12 classes will remain a major source of STEM education via VC there are a variety of other user groups who could benefit from this type of lesson delivery; retirement homes, libraries, juvenile justice
centres, scouting groups, children’s camps, hospital patients and more. The challenges now is to unify education and marketing efforts to improve public understanding.

- Booking systems for STEM VC events are essential for disseminating knowledge of learning opportunities for students and need to support and promotion to be visible. Flexibility in programme offerings is paramount and therefore any system which offers calendar-based events as well as events ‘by request’ is going to be more useful to the classroom teacher. Options for remote sites to join via H.323 VC systems or web conferencing solutions will allow more learners to join. The various booking systems in Australia need to be unified into a funded one-stop portal for any site to find experiences relative to their needs. Freedom for content providers to connect directly to sites should be embraced, with the option to connect through a hosted bridging system for multiple sites available on request.

- High-speed broadband is critical for the take up of high definition video conferencing services; all education sites should do their best to increase their bandwidth capacity to at least 1152 kbps specifically for H.323 video conferencing systems. Wherever possible bandwidth should dedicated to VC systems and not be contended with other networks. In the past educators and students might have put up with grainy pictures, frozen images and call dropouts due to low internet speeds but this is rapidly drawing to a close. Education consumers are beginning to expect more from internet based communications and it is up to network administrators to keep their sites up to date or risk isolating communities.

Video conferencing is not a streaming video, it is a live conversation between two or more sites whereby the participants can hear and see each other in high definition and collaborate on projects in a medium where your locality is irrelevant. Twenty years ago it used to be specialised, expensive and hard to use but now joining in can be as simple as clicking on a hyperlink in an email via a web conferencing platform. Now the task is to communicate these findings to the broader education sector. This Churchill report will be communicated via:

- State and Federal Education departments and Ministries as well as University Faculties of Education.
- Dissemination through the Virtual Excursions Australia network of content providers and VC experts.
- Through the various Australian VC booking systems.
- Principal, science teacher and ICT teaching associations plus professional conferences.
- Through the network of schools already engaging with Fizzics Education for STEM outreach delivery.

Through the uptake of these findings and further sharing amongst networks my hope is that STEM can reach as many learners as possible via VC. Video conferencing systems and web conferencing platforms are now easy to use, are completely supportive of classroom curriculum and are engaging for even marginalized students. The technology should become embedded in classroom practice in every locality – the students love it and have been shown to engage in traditional lessons more!

In summary, no student should not miss out. Let’s together make that happen!
Provider snapshots

Aquarium of the Pacific

http://www.aquariumofpacific.org/education/yourfieldtrip/outreach/videoconf

Formed 1998 and now has 50 educators in peak season with 8 educators assigned to VC duties as needed. They have been video conferencing for 4 years. Their immersive VC room donated by The Roddenberry Foundation and incorporates Chroma key, an A/V mixing desk, document camera and codec system. Re-configuration of the room is a future step planned to accommodate the expanding use of the studio for different back-to-back sessions and the multi-purpose needs.

In 2013 the aquarium reached 4500 students, up from around 2000 students the year before. There are 7 video conferences available. Their sessions last generally for 60 minutes but shorter for younger ages. They have engaged Field Trip Zoom™ to reach learners without H.323 systems. At this stage the demand for programs has been mainly USA-centric with some sessions to Canada and 1 to Australia.

Royal Tyrrell Museum of Palaeontology


The Royal Tyrrell Museum education programmes place relevance of the fossils to Alberta, North America and the global context. Formed 1985, the Museum is operated by the Government of Alberta under the Ministry of Culture. They have been video conferencing since 2006 and are now producing specialised VC content for K to 12 students via 8 sessions. There are 3 educators assigned to VC duties as needed with sessions lasting generally for 45 minutes. Last year they delivered 201 programs to approximately 5045 participants.

Their VC room incorporates Chroma-key, mixing desk, document camera, codec system, multiple monitors and 2 x computers (1 backup) for software and recording. Generally VC lessons are presented as 1:1 sessions to most schools. Constantly updating equipment to keep the sessions at cutting edge eg. New mixer has 4 HDMI channels and can also run in SI. Zoom™ has been engaged as a web-based solution. At this stage the demand for programs has been mainly to USA and Canada, Honduras and Mexico as well as to the Hague (Netherlands) for the past 6 years. They have run a connection to Australia and England as well.
Alaska Zoo

http://alaskazoo.org/education

Established 40 years ago, the Alaska Zoo is a 501(c)3 non-profit dedicated to promoting conservation of Arctic, sub-Arctic and similar climate species through education, research and community enrichment. The Alaska Zoo has newly entered video conferencing in 2014 with 1 educator assigned to VC duties as needed. Video conferencing incorporates a mobile VC system on a trolley with a screen, codec and peripherals attached. Generally they present VC lessons as 1:1 sessions to most schools. Alaskan schools mainly engaged. VC establishment was supported by GCI SchoolAccess.

Future programs to consider multiple cameras at selected sites for better animal viewing. An immersive VC room will be installed in the near future with a Chroma key and document camera addition.

Alaska SeaLife Center


Formed 2004, the Alaska SeaLife Center is a private, non-profit corporation. It is Alaska’s only public aquarium and ocean wildlife rescue centre which has around 150,000 visitors per year. The centre has been video conferencing since 2005 and since commencement distance learning has increased from 2500 students per year to 7000. There are currently 3 educators assigned to VC duties as needed. Video conferencing incorporates 2 movable trolleys with document camera, codec, DVD, computer, monitor, 50x microscope, headset microphone and headphones and lighting. The VC trolleys san run on WiFi or a hard-line internet connection.

Generally most sessions are presented as 1:1 to most schools. There are 11 video conference workshops available. Have run video conferences to sites in the USA, Canada and Australia. Field Trip Zoom™ has been engaged as a web-based solution. New VC equipment is planned to be installed in the animal rehabilitation centre.
History Live was formed in 2011 by the Minnesota Historical Society from funding to show the major 26 Minnesota historical sites and cultural heritage to Minnesota students and the nation. Traditional outreach to schools continues to run however video conferencing has added roughly 5000 students to the audience. The video conferencing uses local historical accounts to tell the broad national stories that are highlighted in the National Standards. Currently there are 2 educators assigned to VC duties as needed with generally most sessions are presented as 1:1 to most schools. Their VC sessions generally run for 45 - 60 minutes. Nine video conferences are offered.

Nina Mason Pulliam Ecolab at Marian University

The NMP Ecolab is established on the grounds of Marian University as an outdoor education site with adjoining hands-on laboratory. The NMP Ecolab offers incursion based programs for K to 12 students in all sciences as well as specialising in biology and conservation. Traditional outreach to schools are offered as well as summer camps on top of video conferencing. All up the centre reaches around 9000 students per year. The video conferencing is highly varied; 22 programs. Currently there is 1 educator assigned to VC duties as needed. The established VC equipment comprises a television, camera, document camera and codec. Generally presented as 1:1 sessions to most schools with the sessions lasting generally for 45 - 60 minutes. Future offerings may soon include earth and/or space-related topics.

Cleveland Museum of Natural History

A natural history museum with a strong palaeontology & archaeology focus including a casting lab which is very helpful when producing specimens eg Dunkleosteus spp. jaw bone. They have been running since VC since 2007 using purpose built 2 distance learning rooms which incorporate 2 cameras, a TV, a document camera and touch
They offer an extensive range of 29 STEM video conferences. They have reached 7 countries and average over 500 connections per year on top of traditional outreach. They have engaged Zoom™ which allows to connect with remote sites as a desktop solution.

**East Central Ohio Education Services Center**


The East Central Ohio Education Services Center commenced video conferencing in 2006. Their video conferencing room incorporates a H.323 VC system, Chroma key, a document camera and an interactive whiteboard. There are currently 18 video conference offerings and they ran roughly 100 sessions last year. Zoom™ has been engaged as a web conferencing solution.

**Cleveland Museum of Art**


Cleveland Museum of Art was established in 1913 and is recognised as one of the world’s most distinguished comprehensive art museums. Video conferencing commenced in 1999. From a presenting/technical staff of 3 the museum reaches around 500 connections per year and some years up to 1000 using two purpose built distance learning rooms. Their video conferencing rooms incorporate Chroma key, a sound/video mixing desk, document camera, lighting and presenter with a headset microphone with multiple backups. Their 55 programs cover K to 12 and range in length from 30 to 60 minutes.

They have reached Canada, New Zealand, Australia, Finland, China, Germany, Ireland and England. In the future they may re-visit high school science presentations via chemistry of art preservation. They have engaged Pexip™ to work as a desktop solution for schools without VC hardware.

**Monroe #1 BOCES**

[http://www.monroe.edu/webpages/dpietrantoni/](http://www.monroe.edu/webpages/dpietrantoni/)

[http://www.monroe.edu/webpages/dpietrantoni/bubl.cfm](http://www.monroe.edu/webpages/dpietrantoni/bubl.cfm)

Monroe #1 BOCES is one of 37 boards of cooperative educational services in New York State as an extension of its component school districts. It develops and implements programs and services that meet the diverse needs of general education students, special needs students with disabilities, talented students, and at-risk students. Video conferencing commenced in 2006 in the Rochester Challenger Learning Center (1 of 43 in USA) and the Bathysphere Underwater Laboratory.
From a presenting/technical staff of 3 the museum reaches 12000 students per year with 1 purpose built distance learning room plus the ability to conference underwater in a local swimming pool. The video conferencing room incorporates Chroma key, a document camera, camera and TV. They offer 10 programs covering K to 12 and range in length from 30 to 60 minutes.

Smithsonian National Air & Space Museum

http://airandspace.si.edu/explore-and-learn/educator-resources/videoconferencing.cfm

The Smithsonian National Air & Space Museum was opened in 1976 and is the largest of the Smithsonian's 19 museums. The Museum's collection encompasses some 60,000 objects ranging in size from Saturn V rockets to jetliners to gliders to space helmets to microchips. Fully one-third of the Museum's aircraft and spacecraft are one-of-a-kind or associated with a major milestone. Video conferencing commenced at the site in 2005

From a presenting/technical staff of 3 the museum runs 150 1:1 connections per year.

There is a planned staffing increase to 5 upon the coming upgrade of the centre which will include a full A/V mixing room adjacent to the Moving beyond Earth gallery and a dedicated digital editing suite downstairs.

Video conferencing is run in 4 ways:

- A movable video conference trolley with connection to mixing station using wireless technology.
- A centre stage arrangement in the 'Moving beyond Earth' gallery.
- Vidyo desktop solution.
- Through Google Hangouts organised through Smithsonian Center for Learning and Digital Access (SCLDA).

International Spy Museum

http://www.spymuseum.org/education-programs/educators/virtual-field-trips/

The International Spy Museum was founded in 2002 in Washington, D.C. The board of directors include former CIA, FBI, KGB, MI-5, NSA and National Security Council Members. It is the only public museum in the United States solely dedicated to espionage and the only one in the world to provide a global perspective on an all-but-invisible profession that has shaped history and continues to have a significant impact on world events.

Video conferencing commenced in 2012 using room with Chroma key, a main camera, touch pad switching and TV which they share as a meeting room with on-site management. They have engaged both Field Trip Zoom™ and Skype™ for learners without H.323 systems. Beyond the USA the museum has connected to Australia

From a presenting/technical staff of 2 the museum runs at least 50 connections a year and there are plans for moving the Museum to a new site in 2017 which may involve a dedicated VC room. There are 4 video conferences available. A Spy fiction series and a Revolutionary War specific program being considered for future VC programs.
New York Hall of Science

http://nysci.org/stem-connect/

The New York Hall of Science was founded at the 1964-1965 World’s fair and presents 450 exhibits, demonstrations, workshops and participatory activities that explain science, technology, engineering, and math. NYSCI was actually doing videoconferencing in 1999 which stopped and then relaunched in 2006. Their offerings involve a dedicated video conference room with camera, document camera, TV and codec as well as two movable video conference trolleys plus a VGo™ robot for students to attend summer camps via remote connection. They reach learners without H.323 platforms via Google Hangouts™, Blackboard Collaborate™ & Safari Montage Live!™

There are 3 types of sessions offered:

a) Virtual Visit Demonstrations running for 30 minutes
b) Virtual Visit Classes running for 45 minutes
c) Virtual Visit Units which encompass 2 sessions; first one poses lesson content and challenge and the second has students report back results (eg. Mathematica beyond numbers)

From a presenting/technical staff of 3 (1 Full time- 2 Part-time) the museum runs 150 1:1 connections per year using the 14 different VC programs available, plus multipoint connections as needed. They have run VC sessions for Ireland, Scotland, Kenya, Australia, Mexico, Canada and England.

There are about 5-6 additional programs exclusively done with chronically-ill patients which includes the Digital Science Labs series In future the future they will introduce iOS based science- apps into video conferencing to simulate a high school science lab environment produce sessions incorporating programs such as Scratch™ & Minecraft™ to teach digital literacy.

Intrepid Sea Air Space Complex

http://www.intrepidmuseum.org/Education.aspx

The Intrepid Sea Air Space Museum is a non-profit, educational institution founded 1982 with the acquisition of USS Intrepid and. Their video conferencing commenced in 2002 for students aged K to 12 and is run using a movable video conference trolley with a camera, TV, codec, touch pad and Smart Symposium™ to present live articles, PowerPoint™ and video within museum galleries. They have also engaged Safari Montage Live!™ & Blackboard Collaborate™. From a presenting/technical staff of 2 the museum runs approximately 24 x 1:1
connections per year with some multisite conferencing as well. Often programs are funded by entities such as Entergy™, Verizon™, Chase Bank™ or working with the Department of Defence Dependents schools. They have run programs for Australia, Canada, Germany & Italy and in future would like to try running sessions on the flight deck as well as a Fuel vs/ Food program for Shuttle video conferences.

**Mote Marine Laboratory**

![Image courtesy Mote Marine Laboratory](http://seatrek.org/)

Mote Marine Laboratory is an independent marine research institution located in Sarasota, Florida. They have been involved in video conferencing for many years; 1989 for satellite broadcasts, 1994 for H.320 (ISDN) connections, 2004 for H.323 (IP) connections and finally 2014 for WebRTC/Skype connections. They use a variety of Blackboard Collaborate Safari Montage Live!™, Skype™, Google Hangouts™ and Zoom™ to reach remote learners without H.323 equipment. The three SeaTrek rental exhibits were originally funded by IMLS and later FL Department of Education and come with an option to connect with SeaTrek Interactive at Mote Marine Laboratory for VC programs.

On average they run about 300 connections per year for 10,000 students per year and have connected to sites such as Canada, Mexico, Greece, United Kingdom and Ireland. Ten video conferences are offered for K to 12. In future they will be incorporating BYOD and project-based learning projects [http://epiforms.org](http://epiforms.org).

**Centre for Puppetry Arts**

![Image](http://www.puppet.org/edu/dis_programs-videoconferencing.shtml)

The Center for Puppetry Arts is established in Atlanta Georgia and is dedicated to the art of using puppets for storytelling and education. They commenced video conferencing in 1998 and use two immersive video conferencing rooms comprising a TV, camera, document camera, codec and peripherals. They also use Vidyo™, Skype™, Google Hangouts™ and Blackboard Collaborate™ to reach learners without H.323 VC units. They run around 600 video conference connections per year from a staff of 2 educators. There are 22 video conferences offered. A new museum wing is planned to be constructed and they plan to incorporate tours using Vidyo or Google Hangouts for BYOD. They run programs for sites in Canada, Mexico, England, and Taiwan.
Mariners Museum

The Mariners Museum is dedicated to present educational experiences on marine exploration. They commenced video conferencing in 2002 using a H.323 VC systems and have also engaged Zoom™. They run up to 300 video conference connections per year and have connected to Australia, New Zealand, Taipei, Spain, Canada, and Puerto Rico. There are 19 workshops offered by video conference. In the future they are be using Google Hangouts™ and plan on pursuing programming for home-school groups as well using Zoom™.

Ann Arbor Hands-on Museum

Ann Arbor Hands-on Museum is a children’s science and technology museum in Michigan. They commenced video conferencing via a grant in 2004 and delivered their first paid program in 2006. They currently use a Cisco H.323 system with Chroma key but also run programs via Vidyo™ and FieldTripZoom™. There are 10 virtual excursions offered. On average they run up to 300 VC programs each year and have reached Australia and Mexico. IN the future they are looking to run VC during Members Nights and Teen or Adult Programming as well as to bring in other content providers would help to enhance and reinforce their mission.

Royal Botanic Gardens Ontario

The Royal Botanic Gardens is situated in Ontario and is a major botanic gardens site in North America. They commenced video conferencing in 2007 using a Polycom™ H.323 system but have also engaged Zoom™ and FieldTripZoom™ as web conferencing platforms. There are 20 video conferences available.
They run up to 250 video conferencing connections per year and have reached Mexico, the United Kingdom, Germany, Japan and Australia.
In the future they will be incorporating BYOD in to their programs as well as experimenting with interactive software (eg NearPod™) and augmented reality software (eg., AURASMA™) as well.

**HEC TV**

http://lhstv.weebly.com/hec-tv-partnership.html

Higher Education Channel TV is a television station operating out of St Louis. They began their videoconference program, HEC-TV Live! in 2008 via H.323 system and Skype™ usually run as multipoint connections with 4 sites. As such they reached over 14,381 students through 312 connections in the 2013-2014 school year. The audience age range is generally Grades 3 through to 12 as well as several libraries in Alaska that regularly connect and they have a growing audience of retirement centres and juvenile justice sites. They have reached Canada, the Philippines, Puerto Rico, and Cypress. They will be implementing BYOD into VC lessons with planned surveys, questions, and quizzes for the coming school year.

**Minnesota Zoo**

www.mnzoo.org/ivc

The Minnesota Zoo originally experimented with donated equipment back in 2008. State grant funds were secured specifically for VC development in 2010 they commenced delivery in 2011 which has now grown to 6 programs. They have engage Cisco Jabber™ and Google Hangouts™ for audiences who had high speed internet and a webcam but not a dedicated H.323 system.

They run programs for K to 12 plus hospitals, prisons, retirement homes, special needs groups and more reaching a total of 271 programs were delivered to an audience of 8,670 individuals in 2014 with just one educator. They have reached Canada and Australia.

**About Fizzics Education**

Fizzics Education has been an Australian provider of interactive science workshops and shows since 2004. Through its science programs and corporate partnerships Fizzics Education presents to approximately 120,000 children each year via incursion and video conference across 400 schools and public spaces throughout Australia and around the world.

Web Resources

Centre for Interactive Learning & Collaboration http://www.cilc.org
Collaborations around the Planet http://projects.twice.cc/
Google Connected Classrooms http://connectedclassrooms.withgoogle.com/
GCI School Access http://www.schoolaccess.net/
NSW Distance & Rural Technologies http://www.dartconnections.org.au/
Senior Learning Network http://seniorlearningnetwork.com
Skype in the Classroom https://education.skype.com/

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