An Examination of Live Interactive Virtual Explorations at the Cabrillo National Monument in Southern California

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Abstract
Building upon lessons learned from the National Science Foundation funded High Performance Wireless Research and Education Network Live Interactive Virtual Explorations (LIVE) pilot project, the Sea to Shining Sea (StSS - http://seatoshiningsea.org) project is expanding concepts from southern California to several National Parks.

Researchers are perfecting development and implementation of a wearable, inexpensive backpack-based system that allows for real-time bidirectional Internet-based video, audio, and sensor data flows between the field and remote audiences. Research also encompasses development of a LIVE Backpack Guide, which explains how to setup and participate in a LIVE session. This paper presents several case studies regarding the use of the LIVE Backpack system at the Cabrillo National Monument and an array of education sites ranging from rural Native American learning centers and schools to urban science centers and museums.

INTRODUCTION

Although San Diego's Point Loma peninsula bristles with antennas and high-tech military communication equipment, high-speed Internet connectivity to the Cabrillo National Monument intertidal area, which is managed by the National Park Service, is problematic due to its hard-to-reach location – beneath jagged cliffs of sandstone along the Pacific coastline.

Meanwhile, nestled in a valley almost 60 miles northeast of Cabrillo tidepools sits the Pala Native American Learning Center, where youth attend preschool, tutoring sessions,

and other educational programs. Similar to the tidepools, Pala Learning Center's access to the high-speed Internet is challenging. Envisioning a live interactive virtual fieldtrip between these two hard-to-reach sites once seemed like a far-fetched notion.

A unique collaboration between the Tribal Digital Village Network (TDVNet), a National Science Foundation (NSF) research project called the High Performance Wireless Research and Education Network (HPWREN), the National Park Service, and the Pala Learning Center have ushered this concept from imagination to reality.

Wiring Remote Reservations to the High-Speed Internet

It all started with a kernel of an idea planted and tended by the HPWREN research project team which hails from the University of California at San Diego, Scripps Institution of Oceanography, and San Diego State University. Back in 2000, these researchers connected not only Pala Native American Learning Center, but also learning centers at Rincon and La Jolla reservations to their high-speed network, which allows users to access the Internet at speeds much faster than the typical cable and DSL connections.

Once these three tribes were connected to HPWREN, the Southern California Tribal Chairmen's Association used the connections as a model to create the TDVNet, which was originally funded by Hewlett Packard back in 2001. Not only does the TDVNet provide high-speed Internet connectivity to San Diego County Native American tribal communities, but TDVNet staff members continue to work closely with HPWREN researchers on novel applications for their high-speed connections.

From Online Tutoring to Real-Time Tidepool Exploration

The high-speed TDVNet provides the Native American community in San Diego County with unique educational opportunities ranging from online tutoring to real-time tidepool exploration. Specifically, HPWREN researchers work with the Learning Center, the TDVNet, and National Park Service staff members to enable participation by Pala youth in Live Interactive Virtual Explorations at the Point Loma tidepools managed by the Cabrillo National Monument.

At the education site, the Live Interactive Virtual Explorations (LIVE) setup consists of an Internet-connected computer running an IP-based videoconferencing software (e.g., Skype or Polycom), a microphone, speakers, and a projector. On the science end, the LIVE backpack system consists of a lightweight backpack (Skull Candy brand) with external shoulder-strap speakers, a Recycled Dell laptop, a Canon 250 digital video camera, a headset, external microphone, and several additional components (e.g., dual audio adapters, batteries, etc). This setup allows both ends to easily send and receive both video and audio – in real-time.

Using the lessons learned from the experiences with the Native American community, HPWREN and NPS researchers are now expanding these Cabrillo LIVE activities to additional audiences. Cabrillo LIVE activities with the Pala Learning Center, the Reuben

H. Fleet Science Center, the California Science Center, and Mountain Empire Middle School are the four case studies presented in this paper.

I. CABRILLO LIVE CASE STUDY: PALA NATIVE AMERICAN LEARNING CENTER

The University researchers were interested in understanding potential impacts of LIVE activities upon youth participants and whether or not such virtual fieldtrips provide children with the same type of educational experience as actually going to the tidepools. An informal activity between a group of after-school Pala Learning Center elementary school students and the intertidal area provided insight for researchers regarding the initial LIVE activities.

Prior to the tidepools tour led by a Cabrillo National Monument Interpretive Ranger, the Pala Learning Center students were given an explanation and able to ask questions about the geology of the area as well as the overall intertidal area at Cabrillo. This took place in a classroom at the learning center and was facilitated by a local geologist, who is known as "Doc" on the reservation as she works with San Diego reservation youth on a regular basis doing science activities. The geologist discussed the sandstone formations found at Cabrillo while an HPWREN researcher provided worksheets and hands-on manipulatives (native southern California sea shells) for the students prior to the LIVE activity. After the introductory activities were completed, the real-time virtual fieldtrip allowed the students to communicate with the Cabrillo park ranger located at the intertidal area. Equipped with the LIVE backpack system (laptop, digital video camera, and headset), the park ranger led the tidepools tour while the children asked questions from their classroom seats sixty miles away (Figure 1).

Though none of the participating children had been to an intertidal area, they were all familiar with the ocean in general and appeared to enjoy both the pre-activities and the virtual real-time tour of Cabrillo tidepools. When informally queried after the LIVE activity, most children said that they learned the most by talking with the park ranger and asking him questions about the animals found in the tidepools. A more thorough study that examines this hybrid approach of science education would be useful; meanwhile, additional informal case studies have been completed.

II. CABRILLO LIVE CASE STUDY: REUBEN H. FLEET SCIENCE CENTER

Using lessons learned from the Pala case study, the researchers modified the hands-on activities at the education site (in this case, the Reuben H. Fleet Science Center) to include not only marine life, but also marine vegetation samples. Twenty five middle school girls were among participants at the LIVE activity between the Cabrillo intertidal area and the Reuben H. Fleet Science Center. Participation in a week-long “Women Scientists in Action” camp at the Center included both classroom activities and an array of science experiments. The LIVE activity allowed the camp youth to focus their studies on marine biology and geology.

Prior to connecting the Science Center end with the Cabrillo end, the girls were presented with an overview regarding the Point Loma intertidal area’s geology by the geologist that

assisted with the Pala Learning Center activity. After this introduction, two NPS rangers (a Cabrillo Interpretive Ranger and the Cabrillo Chief of Natural Resources Management and Science) took the girls on an interactive exploration of the intertidal area. An additional aspect of the activity focused on the HPWREN-connected real-time cameras, which allow people from around the world to view the Cabrillo intertidal area (Figure 2).

While the park rangers discussed the intertidal area with the girls, the Science Center staff set up the hands-on activity, which consisted of marine life and vegetation identification. There were three samples of local marine vegetation as well as three samples of local marine sealife. The girls were given worksheets and asked to identify each species based on the knowledge gained from the LIVE activity. An additional worksheet quizzed the girls on knowledge gained regarding the geologic formations at the intertidal area.

Upon completing the interactive session with the NPS rangers via LIVE and the hands-on activities, the students filled out informal surveys. Several of the respondents suggested improvement in video resolution while others said that they felt the entire presentation was “fantastic”, “great”, and “good”. Many of the informal survey respondents commented that they most liked the real-time crab shown from the intertidal area during the presentation (Figure 3).

III. CABRILLO LIVE CASE STUDY: MOUNTAIN EMPIRE MIDDLE SCHOOL

This experiment involved students sitting in a classroom at a rural San Diego middle school (Mountain Empire) and the Cabrillo marine biologist, who worked with the students’ science teacher to focus the LIVE activity on ocean terracing. Before answering an array of questions posed by the students, the biologist first explained how terracing causes vary, but typically involve erosion. Less resistant rock layers are eroded away and often form overhanging ledges that protect the interidal creatures from strong currents and predators. After this brief explanation of terracing, the middle school students were able to ask questions in real-time, which allowed for an abundance of thought-provoking conversation about ocean terracing as well as other aspects of the intertidal area at Cabrillo.

The setup for this activity varied a bit from the other case studies; that is, a Macintosh laptop was used on the education end while the HPWREN LIVE backpack (as well as a tripod) was used on the Cabrillo end (Figure 4). The weather at the coastal end was quite foggy and prevented detailed vision of the sandstone cliffs at the intertidal area. However, the students were very interested in the difference between the coastal fog and the sunny climate at their nearby (60 miles) location.

For this case study, the middle school science teacher collected informal data from the students:

- "What I found interesting is that I found out what a terrace was. I would like to learn more about where are the most terraces and do any animals live in the terraces. One suggestion to make the field experience better is if we could visit the terraces."

- "What I found interesting is that we got to see the beach. I would like to actually get there."
- "We got to see the fog, all the fossils we saw on the ground were interesting. We need to get there and see everything. We need to actually go there."
- "We got to see the terraces and fossils that are in the cliffs. We should go in the water and look under water at the terrace."
- "What I found interesting was that it was live and we got to ask questions about the terraces which are cool. One suggestion to make the field experience better is actually going to the beach so we can view it better and it's more fun."
- "I found the backpack interesting, but what kind of creatures live on the ocean floor. And actually going there is better."
- "It was so realistic I felt like I was there. If people use to live around there I would like to know more about that. I would like to have our own computer with a webcam instead of looking up front of the room."
- "I liked when we learned about the tidepools and how they worked when we got to learn about the details and important things about the tidepools and we got a good footage. I would like to know more about the terraces. To actually try going to the field trip and go there to experience it ourselves and not do the computer thing."
- "I thought the field trip was cool because I learned more about terraces and how they are made and how long it took for them to fully develop. I would want to learn more about the terraces and actually go there and not on web cam."
- "What I found interesting about yesterday's field trip was how old the terrace can get. What I would like to know more about is the new terraces forming. One suggestion to make the field experience better is going there."

IV. CABRILLO LIVE CASE STUDY: CALIFORNIA SCIENCE CENTER

The case study between Cabrillo intertidal area and the California Science Center in Los Angeles was one of the researchers' first attempts at LIVE activities. Third grade students from the Science Center School participated in a real-time fieldtrip between a classroom-type setting at the Science Center and the tidepools. The LIVE activity allowed the students to directly communicate with an NPS Education ranger as well as watch real-time video from an underwater camera attached to a submersible Remotely Operated Vehicle (ROV).

The ROV camera was able to send back real-time underwater video of anemone, hermit crabs, coralline algae, kelp, and sea grass. Simultaneously, the students discussed what they were seeing with the NPS ranger on the Cabrillo end. As there was an encroaching storm during the activity, the youth seemed to be most interested in how such small marine life survives in an environment with big waves and cold temperatures. The education ranger was able to show the answers in real-time, rather than just using words for an explanation. For example, one student asked what would happen to the creatures in the event of a hurricane and the ranger showed them smaller rocks, which would be tossed around, and larger rocks with crevices in which animals would likely be minimally impacted by a hurricane.

The use of the ROV made this first case study perhaps the most interesting. Use of the ROV during additional such activities has been problematic, however, due to staffing. In order to run the ROV while simultaneously conducting a meaningful LIVE activity takes a number of people at the Cabrillo end, which is not always feasible.

CONCLUSION AND FUTURE RESEARCH

While the University and NPS researchers continue to work together for additional case studies, a LIVE backpack manual has been created to ease the use of the technology on the Cabrillo end. This LIVE backpack manual allows a park ranger to easily slip on the backpack system and provide a glimpse of the Cabrillo intertidal area to students sitting in their classrooms. The biggest challenge is the videoconferencing software that is currently being used (Skype and Polycom) as a large number of schools employ firewalls that prevent the use of such applications. Because of this, the researchers are limited to working with education sites that do not have such firewalls.

In addition to this software challenge, which is being addressed by continued research and experimentation with alternative IP-based videoconferencing software, the hands-on activities are also somewhat challenging. While LIVE participants are clearly interested in the education site activities and appear to learn from them, a more formal evaluation of how these enhance their science education would be worthwhile. Such a study was conducted by Tan, Liu, and Chang in 2007; they focused on the impact of a combination of traditional classroom experiences with remote outdoor learning and found significant increases in learning among the participants. Additional studies by scholars such as Sun, Lin, and Yu (2008) and Mazzolini and Maddison (2007) might be considered as models for evaluating impact and how best to proceed with LIVE activities.

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