SELF-CONTAINED VIRTUAL FIELD TRIPS IN COMMUNITY SCIENCE THROUGH POINT-TO-POINT VIDEOCONFERENCING

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in
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Science Teaching

by
Raymond Luis Barber
Spring 2010
SELF-CONTAINED VIRTUAL FIELD TRIPS IN COMMUNITY

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DEDICATION

I would like to dedicate this project to my family, friends and colleagues who have supported me throughout the last four years of this educational endeavor.

To my mom and dad, who have provided me with so many wonderful things throughout my life, the greatest of which have been their love, encouragement and values.

To my children, Braden and Bailey, for your patience and understanding while daddy “went to the big school” and then “wrote his book.”

And especially to my wife and best friend, Valerie, whose unconditional love, encouragement and support allowed me to be at the same time a father, husband, teacher and a full-time student. Your contribution to this project was the greatest of all.
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ABSTRACT

SELF-CONTAINED VIRTUAL FIELD TRIPS IN COMMUNITY SCIENCE THROUGH POINT-TO-POINT VIDEOCONFERRING

by

Raymond Luis Barber

Master of Arts in Interdisciplinary Studies Science Teaching California State University, Chico

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This project focused on the use of videoconferencing technology to connect students in the classroom to the relevant and applicable science in their own community. Small groups of students, equipped with computers and video cameras, traveled to local scientific facilities and conducted live and interactive virtual field trips for their classmates who viewed the videoconference from the classroom. The classroom students had the opportunity to interact with the field group, ask questions of the expert scientist/host, view equipment and processes, and assist in data and sample collections. The six different field trip sites incorporated content in areas such as astronomy, chemistry, stream dynamics and sound waves and recording, while relevant activities before and after each field
trip served to reinforce the respective science content. This virtual field trip project, while incorporating various aspects of other similar programs, was unique with respect to two important factors. Field trips were: 1) located within the community relatively close to the school site, and 2) self-contained; that is, produced by students for their classmates. Results of the project indicated that: 1) videoconferencing technology is a viable means of remotely linking the classroom to the field; 2) there was a positive effect on students’ attitudes of and motivation in science; 3) students’ perceptions of their own learning increased.
CHAPTER I

INTRODUCTION

Experiences outside the classroom improve the conceptual understanding and motivation for learning that occurs in any subject, particularly in science where the application of scientific principles can be demonstrated on site at the field trip destination. Substantial research has established the importance and effectiveness of field trips in enhancing science education (Benz, 1962; Lisowski & Disinger, 1987). Kern and Carpenter (1986) determined that earth science students involved in field work were able to process and retain the particular concepts at a higher level as compared to their classmates who were confined to comparable activities in a classroom. Studies indicate that students learn even more from this type of experience when the field trip is preceded in the classroom by instructional materials (Gennaro, 1981) and when students actively participate in the fieldwork being conducted (MacKenzie & White, 1982).

Regardless of their inherent benefits, field trips are not used extensively to supplement the public high school curriculum for two primary reasons: 1) the high financial cost associated with the transportation of the students to the field trip site (Cassady, Kozlowski, & Kormann, 2008; Pachnowski, 2002), and 2) the academic cost to students who miss their other scheduled classes (Tuthill & Klemm, 2002). This project serves to eliminate these two barriers by allowing students to experience field trips through the use of videoconferencing technology. Small groups of 6-8 students, equipped
with computers and video cameras, traveled to local scientific facilities and conducted live webcast tours for their classmates watching and interacting from the classroom. Viewing the webcast on a projector, the students in the classroom had the opportunity to interact with the field group, asked questions of the expert scientist/host, view the equipment and processes in use, and assist in data and sample collections. All 30-35 of the students in the designated participating classes had the opportunity to help plan all the field trips, interact with the presenters and see firsthand how the facilities worked.

Six different field trip sites were chosen based on their potential to extend and enhance the standards-based curriculum of the introductory physical science class (Appendix A). The sites incorporated content important for: astronomy, chemistry, stream dynamics, and sound waves and recording. A different group of students served as the guides and technical staff for each field trip. This rotating model allowed for maximum student participation giving all students the opportunity to participate in all field trips while only missing one partial day of school. Students were able to experience the enrichment of a field trip without compromising the rest of their academic classes. Each webcast was also recorded, edited, and posted on the director’s website as an archived record of the experience. This allowed students who were absent to view the webcast, although not in an interactive way, and to preserve the record for additional and future science classes.

The primary goals of this project were to: 1) integrate science and technology with community scientific applications, 2) promote student interest in, and 3) enhance students’ perceived performance in science. By providing field trip experiences beyond what would be feasible under ordinary classroom circumstances, I anticipated that
students would take a more active role in their learning and perform better in their science classes with the field trip experiences.

This project serves as a model for educators to enrich their instruction with experiential learning by taking their students on field trips, but who cannot do so either because of financial or logistic limitations. The field trips described here are not only standards-based, but are focused on local community businesses or educational facilities. This has an additional advantage of introducing students to resources in their community.

This is the first time this type of virtual learning project has been attempted. While there are many, well-documented cases of other projects having videoconferenced field trips between a participating school or informal science settings (museums, zoos, etc.), this is the first instance in which students of the same school have traveled to a local area to host a live virtual tour for their own classmates. This project is unique in that it is self-contained; that is, our students will not need to rely on any support from outside sources, particularly web based resources, for videoconferenced content.

This model of exposing students to real world experiences reduces the significant financial costs associated with transportation that are typically associated with school sponsored field trips. These include: the number of buses, the hourly rate of the bus driver(s), insurance, and fuel/maintenance mileage rate factored as the round-trip distance to the field trip site. As an example, transportation for two classes of students (70 students total) on a four-hour field trip, fifteen miles from the school site, would cost nearly four-hundred dollars. This also factors in the cost of an additional certificated staff member to accompany students on the second bus.
This model also, and more importantly for the students academic welfare, is the high academic cost incurred by students who miss an entire day of classes as a result of attending a field trip (Klemm & Tuthill, 2003). In a typical high school day students attend six, 56-minute classes with each class being taught by a separate instructor. Not only are students missing instructional time in their respective classes, but they place an additional burden on teachers who are required to provide make-up work and/or any instruction. This usually takes place outside of the regular class meeting time and is a less than satisfactory replacement for the actual, full-length instructional period. Moreover, because these 70 students all have different schedules and different teachers, a four-hour field trip can potentially impact 20 other teachers on a secondary school site. For both the financial and academic cost, it is not surprising that field trips, while educationally effective, are not regularly used as an adjunct to instruction (Klemm & Tuthill, 2003; Tuthill & Klemm, 2002).

Technical Considerations

In addition to the field trip being webcast by three cameras (two in the field and one the classroom), these cameras also recorded their respective view from each field trip onto videotape. An additional video camera, not connected to a computer or the webcast, was also used to record from an additional perspective. Video from all four cameras was downloaded into a computer, synchronized and edited into an approximately 20-minute video, which was posted to the director’s website for access by other students and at a later time.
Whereas financial limitations do not need any additional explanation, logistic limitations overcome by this methodology included venues in which there was a limited amount of space available for students to be physically present. For example, the size of the room in which students in this project observed neon signs being constructed was too small to accommodate two entire classes of students (60 students). An additional logistical obstacle bypassed by this approach might involve safety concerns (Cassady et al., 2008; Pachnowski, 2002). In spite of the fact that the size of the facility at Orient and Flume Art Glass site could have easily accommodated a sizeable group of students, the company’s safety guidelines only allowed fifteen students in at one time.

All six field trips directly supported current standards in the California State Science Framework inherent in the curriculum for an introductory physical science class designed for ninth grade students (Appendix A). For example, during a unit on atomic structure, a field trip to a neon sign manufacturing shop was scheduled to allow students to explore how light is produced by elemental gases in a tube when exposed to high energy. Students were provided an overview of the nature of the field trip and then asked to generate a list of potential questions. Then, as they watched the live webcast of the field trip, students in the classroom would have the opportunity to ask questions, both content and procedural.

Activities that supported concepts illustrated within the field trip were conducted with the students either before and/or after the trip. To prepare for the Sierra Nevada Brewery field trip, students created and then identified a set of twenty different mixtures as either solutions, colloids or suspensions. This included using light to distinguish between solutions and colloids through interpretation of the Tyndall effect.
Following the field trip, students investigated methods by which mixtures could be separated that included: filtration, centrifugation, distillation and electrophoresis. A laboratory investigation using paper chromatography to determine the relative quantities (recipe) and colors of inks used in a brown water-based marker was also completed (Appendix B).

In some cases, data and/or samples collected from the field trip site were analyzed by the students in the days following. Observing how the same concepts they learned about in the classroom are readily applied in real-world applications allowed students to expand their knowledge of science principles.

Additionally, this current generation of students is experienced and proficient using emerging communication technology such as Facebook, Twitter, or Google Groups. This factor makes the current project even better-suited to student life and learning styles. Through the use of social networks, students have developed a comfort level communicating over the internet. The advantage with the methodology in this project is combining electronic communication with face to face aspects such as learning to read body language and becoming familiar with interviewing techniques.

This project is unique since it is the first instance of a virtual field trip that employs a group of students conducting a live and interactive webcast of the field trip for their classmates back in the classroom. Because of the self-contained nature of the field trips, the students had the ability to discuss, plan and implement much of the content of the field trip. This included potential questions on a particular area of focus as well as any data/samples that were to be collected and returned to the classroom for further investigation or analysis. Moreover, because the video and audio connection to the field
trip site was live, students in the classroom had the ability to interact with the traveling group and/or host. Because all students involved in the project were a part of the same class, each field trip was undertaken from the perspective that each student was part of a larger team working cooperatively towards a common goal. From its inception, the project was designed to both inform and instruct, not only the students directly involved with the project, but those students who also viewed the video of edited webcasts on the director’s website.

Many people in the community surrounding our district, let alone students, do not realize the extent to which science is used in the daily manufacturing of goods in a community. In this respect, the project was aimed at communicating to the students a comprehensive “behind-the-scenes” view of what occurs at each of the six field trip sites. Many of the questions that students asked during the course of the project proved to be informational in nature. Some of the questions students asked during the project included: “Can touching a neon light electrocute you?”, “Why is that microphone so expensive?” and “How long does it take the vase to cool?”

Limitations of the Project

Cost

One of the fundamental limitations of this project is its initial cost of equipment and hardware used to complete it that was available at the time this project was conducted. The purchase of three laptops, three video cameras, a video projector, and various additional audio and video accessories amounted to nearly $5000. However, this is not to suggest that this type of project could not be completed by using a different
computer platform and/or operating system with equipment currently owned by a school or district or that recent developments in technology would be applicable.

Learning Curve for Students

Each group of students who conducted the field aspects of the trips had to learn how to operate the equipment, hardware and software, including videography techniques, electronic technicalities and well as aspects such as interviewing and public speaking skills. The learning curve necessary to become skilled in these aspects was a direct result of rotating students through the leadership roles to produce each webcasted fieldtrip. The learning curve necessary to become skilled using the equipment could have been eliminated had a single group of ten students been trained, and conducted all six of the project’s field trips. However, the intent here was to provide each student with an active role in as many aspects of the project as possible and this meant that a different group of students accompanied the teacher to each of the six field trips throughout the project’s duration. While this model provided the opportunity for all students to travel and experience at least one real field trip, this meant that no single group of students ever had the chance to become increasingly proficient at setting up and using the equipment and software.

Privacy Issues in the Workplace

Potential local businesses and/or points of interest that could complement the ninth-grade physical science curriculum were selected and contacted. The project director visited each and learned that, while all potential sites welcomed students for a field trip, several of the businesses contacted were unwilling to allow any form of cameras into their facility. Some cited issues with associated company trade secrets, while others
indicated company policy enacted as a result of the terrorist attacks on 9/11. So the very use of the video technology aimed at making field trips more accessible, in some cases, actually limited accessibility.

**Time Limitations**

Most of the businesses/sites we planned on visiting preferred conducting the field trips in the morning as opposed to the afternoon. Because the traveling group of students would be webcasting the field trips live back to the classroom, those science classes involved in the project would need to be scheduled in the morning as well. It was possible to organize the school’s master schedule to accommodate this requirement. Because there were two periods involved in the project, the host would perform one 30-minute “tour” with Period 1 students, a 20-minute break for a passing period, followed by a repeat of the field trip for the 2nd period students. It is important to mention, however, that the concurrent scheduling of classes gave students a chance to practice their interviewing and videography techniques a second time, thus positively influencing the learning curve in using the equipment. During each field trip the traveling group of students had to webcast the same content twice: a first time for the first period class, and a second time for the second period class. In a sense, the first webcast served as a live “dress rehearsal” in which any technical or logistical problems that arose were addressed and resolved for the second webcast for the next period.

**Aligning Field Trips to Curriculum**

**Academic Content Timeline**

Another limitation involved the scheduling of specific field trips that would coincide with the curriculum. Although every effort was made to coordinate this, some
businesses simply could not accommodate the project schedule for a variety of reasons
including: regularly scheduled maintenance, peak production time, available staff to host
a session or, in those field trips involving the university, midterm and/or final exams.
This required that the curriculum be flexible. In some situations the field trip came at the
beginning of a unit, in other cases it was a culminating activity.

Communicating with Businesses

The inherent nature of the project requires the cooperation of the local
business or site. In addition to considering the potential content/concepts illustrated by
particular venue, however, the success of this virtual field trip project hinges on several
fundamental requirements.

A primary requirement to successful webcasting of the field trip is access to
an internet connection with sufficient bandwidth to provide the best possible audio and
video experience for students viewing in the classroom. In any large corporation,
however, the internet is typically accessed through a larger, private network infrastructure
that connects and manages all computers within the company. While most of these
personal computers are most likely used by individuals for daily business operations,
some networked computers and/or servers are used in controlling intricate, but vastly
automated manufacturing processes. Any disruption of this side of the network ultimately
results in a loss of time and/or production for the business. With this in mind, it is not
surprising that some businesses have policies which strictly restrict and or prohibit any
public access to their internal network. In some cases, the business may provide
accommodations by allowing access to their own wireless network. Frequently, however,
security settings on these routers are set to such high levels that it impedes data transfer
and results in poor audio and/or video quality for videoconferencing. Additionally, at any given distance the strength of the signal produced by wireless access points varies between different manufacturers. Weaker signals impart a lower data transfer rate which also leads to poor video and/or audio quality.

Another provision to consider is scheduling. Field trips should be scheduled concurrently with the concepts they are designed to illustrate within an established curriculum. A more specific logistical consideration is scheduling field trips to coincide with the daily meeting schedule of those classes participating in the program. This also raises the issue of how many times the field trip will need to be repeated for each respective class participating in the project. For example, if three periods of Biology classes will be visiting greenhouses of local wholesale nursery, that field trip would need to be conducted and webcasted three separate times for each respective period of students.

While most cooperating field trip sites are able to make these provisions, the reality is that some may not. It is reasonable that corporations may wish to limit access to their network. However, if they are willing to provide access by deploying a temporary wireless network, arrange a meeting with the company’s network analyst to test the connection before the actual field trip. While this may require the cooperation of a staff member or colleague at the school site, it is important to maintain the conditions of the network in order to properly assess the potential quality of the videoconference. During the test, make note of distance versus wireless signal strength to determine the usable perimeter from the access point. If the size of the field trip venue requires the use of multiple access points, then plan on a few minutes of down-time as students move from
one area to another, acquire the new wireless signal and then re-establish the videoconference with the classroom.

Whether the order of the field trips determine the order of the curriculum or vice-versa, it is important to plan well ahead of time, make a commitment and then stay with your plan. Invariably, a business owner may tell you that, for whatever reason, the scheduled field trip may need to occur earlier or later than originally planned. If earlier than planned, then use the field trip as a way of introducing the unit and, if later, as a culminating event that serves to summarize and unify the unit.

Another suggestion may be to prepare an informational flyer that would be provided to businesses upon initial solicitation. In addition to an overview of the project, it could list a potential time period for conducting the field trip to coincide with the curriculum and points of particular interest that would best illustrate the concepts being studied. Technical and logistical requirements could be included: access to the internet, minimum bandwidth, number of students attending, and parking.

**Choosing and Working with a Host**

A host/guide for the field trip will most likely be chosen by the respective businesses/sites that are visited. To provide the best possible learning experience for the students, however, it is important that the host has a clear understanding of the goals of the field trip. While the hosts should be knowledgeable enough able to explain all aspects of the field trip site, explanations should be on the same educational level of the concepts the field trip is supporting. Therefore, the content of the field trip should be thoroughly discussed with the host before the date of the actual field trip. Included here would be
breadth and depth of content, as well as a timeline that determines the order and length of
time to be spent on each concept.

Issues regarding safety should also be discussed with the host during planning
talks. Although the host may have extensive experience in leading groups of people
through their particular site, it is important to remind them that this group of students may
be distracted by the equipment they are handling. Any obstacles, areas of confinement,
and physical hazards should be identified and discussed with students of the traveling
webcasting group before the actual day of the field trip and mitigated or acknowledged.
Additionally, it is important to verify that the host has permission from the owner to
access those areas that will be visited by students. This promotes a good, working
relationship with the cooperating business owner and those prospective business owners
who may wish to host future field trips.

**Definition of Terms**

**Algorithm**

“A sequential problem-solving procedure” used as a means to reduce file size
(compression). The same algorithm is also used to decompress the data (“Algorithm,”
2009).

**Bandwidth**

“The amount of information that can be transmitted over an information
channel. . . . In computers, bandwidth is the speed at which data can be transmitted on a
communications frequency” (“Bandwidth,” 2009).
Broadband

“Telecommunication in which a wide band of frequencies is available to transmit information. Like a highway with more lanes, broadband is broken down into various channels which allow more data to travel over the line at the same time”

(“Broadband,” 2009).

Codec (Coder-Decoder or Compression – Decompression)

Videoconferencing hardware uses a codec to code the outgoing video and audio signals and decode the incoming signals. Prior to transmission, the codec converts analog signals to digital signals and compresses the digital signals. Incoming audio and video must be decompressed and converted from digital back to analog.

(“Codec,” 2009)

Compressed Video

Compression is the reduction in size of data in order to save space or transmission time. Transmission of compressed video over a communications network requires sophisticated compression algorithms. Some videoconferencing systems offer both proprietary and standard compression algorithms. (“Compressed Video,” 2009)

Continuous Presence

“The screen is split into quadrants and allows multiple sites to be viewed simultaneously on the same screen” (“Continuous Presence,” 2009).

Desktop Videoconferencing

“Videoconferencing on a personal computer. . . . Desktop videoconferencing systems support a variety of interactive activities including document sharing, whiteboard use, and chat” (“Desktop Videoconferencing,” 2009).

Echo-Cancellation

Firewall

A combination of hardware and/or software measures used to protect internal data from internal and external hazards. “In order to videoconference over an IP network with a firewall, ports are assigned to handle the video” (“Firewall,” 2009).

Frame Rate

“Frequency in which video frames are displayed on a monitor, typically described in frames-per-second (fps). Higher frame rates improve the appearance of video motion” (“Frame Rate,” 2009).

Full Duplex Audio

“2-way audio simultaneously transmitted and received without any interference or ‘clipping’. A common feature of room-based videoconferencing systems” (“Full Duplex Audio,” 2009).

Full Motion Video

“Full motion video is equivalent to broadcast television video with a frame rate of 30 fps. Images are sent in real time and motion is continuous” (“Full Motion Video,” 2009).

IP, Internet Protocol

Internet protocols are used to communicate across any set of interconnected networks. Internet protocols can be used to specify common applications such as electronic mail, terminal emulation, and file transfer (“IP, Internet Protocol,” 2009).

ISDN

Integrated Services Digital Network (ISDN) “is a high-quality, switched digital communications service which allows standard phone” lines “to transmit voice
and data simultaneously.” These “same lines may be used for regular telephone service, faxing, computer communication, or even live videoconferences. Each of these applications requires suitably equipped customer-provided equipment” (“ISDN,” 2009).

**Multipoint Videoconference**

“Videoconference with more than two sites” (“Multipoint Videoconference,” 2009).

**Point-to-Point Videoconference**

Videoconference between two sites.

**Protocol**

“A standardized format for transmitting data between two devices. The protocol determines error checking, data compression, and the formal beginning and end of messages” (“Protocol,” 2009).

**Videoconferencing**

“Communication across long distances with video and audio contact that may also include graphics and data exchange” (“Videoconferencing,” 2009).

**Virtual Field Trip**

In the context of this particular project, a conventional field trip which, through the use of videoconferencing technology, is experienced by students at a different location (i.e., a classroom).
CHAPTER II

REVIEW OF RELATED LITERATURE

Published research on the benefits of field trip experiences is extensive and has established support for the hypothesis that investigations that occur beyond walls of a classroom can have a significant and positive affect on students’ cognitive, affective and psychomotor skills. Most teachers will agree that field trips are an important part of the educational experience providing students with valuable context outside the formal classroom setting (Braund, Reiss, 2006; Cassady et al., 2008). Field trips give students a chance to engage actively with information in a real-world setting, creating memories of the experience that last long after the excursion is over. Long-term retention and understanding of the outing can be increased by both aligning the field trip to course curriculum and having students complete related follow-up activities (Knapp, 2000).

In early studies, researchers like Benz (1962) observed that, initially, there was no significant difference in content knowledge gained between an experimental group that traveled to a field trip site and the control group that remained in the classroom. However, over time, the results of pre- and post-assessments administered to each group indicated that higher-performing students were more likely to retain content.

In a more recent, controlled research study by Australians MacKenzie and White (1982), three different sets of students participated in an investigation of coastal geography. The first group of students remained in the classroom, studied slideshow
photos of the field site and answered the program questions. Two other groups of students traveled to the field. Of these two groups, one (traditional excursion) was provided with all of the information and direct instruction they would need to answer the program questions. The second field group (processing excursion) was guided by the instructor in exploring the site and the students gathered the information required to answer the questions. These students were actively engaged in the lesson by having to make observations, draw, record, and answer questions. After twelve weeks, the field group that took an active part in processing the information had a retention rate of 90% as compared to 58% in the passive field group and 51% in the classroom group.

Kern and Carpenter (1986) conducted a similar study to determine how field activities affected student learning. One group of college-aged earth science students remained in the classroom and completed activities from an accompanying laboratory manual, while the another group of their classmates completed their activities in the field. At the end of the study, results showed that lower-order thinking skills (memorization) were the same in both groups. However, students in the experimental field trip exhibited significantly greater higher-order thinking skills, demonstrating an increased capacity in applying the information.

Additional evidence to support the value of field trips is presented by eleven California secondary schools which participated in an outdoor environmental education program. With respect to academic assessments in language arts, math, science, and social studies, on average, students in the outdoor program earned higher scores in 72% of these assessment than students enrolled in traditional schools. Assessments with the highest percentages included those in language arts (76%) and social studies (73%) (State
Education and Environmental Roundtable, 2000) When combined with the national data, the average percentage for the same set of assessments rose to 77%.

The National Science Education Standards supports the value of learning outside the classroom by stating that “the classroom is a limited environment. The school science program must extend beyond the walls of the school to the resource of the community.” Additionally, these resources “can contribute greatly to the understanding of science and encourage students to further their interests outside of school” (National Research Council (NRC), 1996, p. 45). Museums, zoos, national parks, science centers, planetariums or even one’s own backyard, are all considered to be informal learning environments in that they exist “outside the traditional, formal schooling realm...” (Dierking, Falk, Rennie, Anderson, & Ellenbogen, 2003, p. 108).

Although the research has shown that field trips have the potential to produce positive outcomes in student learning, field trips are not as frequent as the evidence suggests they should be given their educational success. There are several reasons for a lack of field trip experiences that are cited in the literature: cost, loss of instructional, or seat time in the classroom, and safety. Extensive financial costs are associated with taking students away from the classroom any distance. These may include transportation, admission fees, equipment and/or any associated substitute costs (Zanetis, 2010). Loss of instructional time is another often cited restriction to leaving the classroom, especially at this time when teachers and schools are being held accountable via standardized testing scores. The idea of foregoing valuable instructional time in exchange for a more open-structured learning experience, such as a field trip, is simply not an option for some. Safety and liability issues are also barriers often insurmountable for large groups of
students and in certain venues (Cassady et al., 2008; McCombs, Ufnar, & Shepherd, 2006; Pachnowski, 2002; Ramasundaram, Grunwald, & Mangeot, 2004).

Regardless of the situation, overcoming any challenge requires reflection and, ultimately, innovation. The following literature relates to the measures educators have taken in their attempts to overcome some of the primary barriers, financial and logistical, associated with taking field trips. One of these, the virtual field trip, is of particular interest for this study and will be described in detail. According to Klemm and Tuthill (2003), “the term ‘virtual field trip’ embraces a range of instructional approaches and technologies but generally denotes a multimedia presentation that brings the sights and sounds of a distant place to the learner through a computer” (p 178). Virtual field trips are not meant to replace traditional field trips, but rather, to provide students and teacher access to those resources they would not have otherwise. The expectation is that virtual field trips might somehow encourage students to continue their learning by actually visiting these scientific points of interest (Cassady et al., 2008).

While the word “virtual,” as it applies to field trips, is as relatively new as the technology it employs, teachers of an earlier time took their students on virtual field trips through the use of photo slideshows (MacKenzie & White, 1984). Although archaic by today’s standards, this author distinctly recalls several of his childhood teachers preparing slideshows of places visited during their summer break. Seeing my teacher in a photo with the vast panorama of the Grand Canyon in the background somehow added a sense of realism to this place I had never visited. And although I had seen photos in textbooks, seeing someone I knew in the photo provided the proof that this place actually existed and the “virtual” achieved personal meaning.
Today’s technology allows for two types of virtual field trips: asynchronous and synchronous. Asynchronous virtual field trips “are not delivered in real time” (Zanetis, 2010, p. 20) and historically, have been websites which incorporate various forms of multimedia such as photos, video clips, audio and text (McCarthy, 1989). Today, they can be much more interactive than just the slideshow and can include live video, online polls, and participant interaction through instant messaging or phone questions and comments (Cassady et al., 2008).

Asynchronous field trips, “webquests,” “online” field trips or “cybertours,” can be constructed by teachers using inexpensive digital cameras and readily available web-authoring software. Each webpage is linked to one or more different web pages via a hyperlink. How these links are organized determines how the user will navigate through the field trip. Sequentially ordering the pages provides that all students will see all pages and have the same experience, while organizing the links as a web allows for a more open-structured and interactive experience. Asynchronous virtual field trips provide for a more individualized experience as compared to a single, passive and teacher-directed slideshow (Klemm & Tuthill, 2003). Students can progress through the material at a pace that allows them time to process the information before moving onto the next concept. (Citrola, 2008)

Most early web-based field trips were authored by classroom teachers, but today most virtual field trips are authored by teams of professionals proficient in webpage design and experienced with distance education. A number of virtual field trip providers now have websites with collections of programs available for teachers to incorporate into their curriculum free of charge (Zanetis, 2010). A research study by
Spicer and Stratford (2001) revealed that although students enjoyed asynchronous, web-based virtual experiences and thought the virtual field trip was useful as a primer for a real field trip, they all agreed that it could not take the place of an actual field trip.

Videoconferencing has recently become a feasible way of inserting more interaction into virtual field trips. Commonly used in the business sector to facilitate executive-level meetings, advancements in this mode of communication are resulting in its use in distance learning applications. Videoconferencing is especially useful in synchronous field trips, trips that happen in real time. The following literature summary reflects on the effectiveness of videoconferencing as a teaching tool in K-12 field trip settings.

Virtual field trips that are synchronous are delivered in real time, typically through the use of some form of videoconferencing. Because both parties, the host in the field and students in the classroom, can see and hear each other, live interaction between the two sites is possible. Thus, synchronous field trips are sometime termed “interactive” field trips (Zanetis, 2010).

Research on the effectiveness of interactive field trips dramatically illustrates their effectiveness in stimulating learning. A study conducted by Cassady et al. (2008) compared the performance of students’ experiences on an electronic field trip to the Grand Canyon. The experimental group experienced the field trip using both web-based materials and a live videoconference with Grand Canyon park staff, while the control group had access to the web-based materials only. The experimental videoconferencing group retained more knowledge about the trip, scoring significantly higher in assessments designed by the park staff (Cassady et al.).
Specific aspects of these interactive field trips have been investigated, particularly in the Remote Accessible Field Trips (RAFT) setting. The Remote Accessible Field Trip project (Bergin, Anderson, Molnar, & Baumgartner, 2007) studied several learning outcomes with respect to two different distance learning experiences (virtual field trips). Students were divided into two groups, the video interview group and the data transfer group.

The first group of students (the “video-interview” trial) used only videoconferencing to carry out virtual field trips. Similar to the visitation procedure use in this project, small groups of students in the RAFT study traveled to an artist’s studio or scientist’s laboratory and conducted a live videoconference with students in the classroom. The videoconference provided live interaction between the two groups and sessions were recorded for consideration, creation of web pages and formulating conclusions.

The second group of students, the data transfer group, all had assigned, specific roles (coordinator, data gatherer/collector, scout, field coordinator) including students in the classroom as well as those in the field. In this part of the study, students in the field used hand-held computers to gather and transmit data to the classroom. This group was referred to as the “data transfer” trial because no videoconferencing was used in this portion of the study.

In the data transfer trial, students both in the field and in the classroom maintained a high level of interest during the experience and felt it was beneficial. In the video interview trial, however, this level of interest and benefit was only maintained by
the group in the field and not the students in the classroom, suggesting that student
engagement is a critical component in sustaining student interest.

Newman (2007) lists and describes several different forms of
videoconferencing used in K-12 education. Point-to-point videoconferencing, also
referred to as provider classroom, allows for direct communication between a classroom
and museums, zoos or science centers which provide videoconferencing programming.
Sessions are hosted by educational specialists on staff with the content provider and who
are trained in using the technology. Multipoint videoconferencing is similar to point-to-
point, however a videoconference is shared between three or more geographic locations.
That is, classrooms in California, Texas, and Maine could all participate in a content-
provided program hosted by NASA at Cape Canaveral in Florida.

Newman also includes another type which she calls electronic field trips,
which, if considering only the name, could easily be mistaken as the type employed by
this particular project. Instead, she describes electronic field trip videoconferences as
unique, one-time experiences that are primarily initiated by the content provider and
broadcast live to many different classrooms at once. The content of the broadcast may
include programming such as a launch of the space shuttle, an eclipse, or gatherings of
war veterans. Bearing in mind that thousands of students across the country participate in
the field trip, these types of videoconferences are more “provider-centered,” especially
considering the limited interaction (Pachnowski, 2002). Nevertheless, it is the classroom
connection to these events and “real” people that have a positive effect on student
knowledge, retention and attitude.
Another study conducted by Newman (2007) examined the effect of videoconferencing with an external provider such as a museum, zoo, or outside expert scientist. Results indicated that students who utilized videoconferencing obtained higher assessment scores and had better attitudes about their learning experience than those students who completed the lesson without the technology. Additionally, research within the videoconferencing group parallels findings in the RAFT study: students that are actively involved in the experience are more likely to have a positive effect on student attitude and achievement as compared to students who play a more passive role in the field trip.

In a summative evaluation of a five-year project involving the use of videoconferencing technology to facilitate distance education programs, participating teachers reported that, “videoconferencing allowed the ‘real world’ to come into the curriculum” (Newman, 2006, p. 76). Teachers also noted that the technology was most effective when students were provided with programming that matched their interests and that students who participated in a videoconference were much more engaged than they were during a traditional lecture (Newman, 2006).

Researchers Jonassen, Davidson, Collins, Campbell, and Haag (1995) suggest that videoconferencing has the potential of redefining real-world contexts. Even though it is technology-based, the live interaction between two remote learners promotes collaborative and constructivist learning environments.

While field trips enhance student learning and motivation, factors such as cost, safety and loss of instructional time prevent teachers from utilizing them. In an effort to minimize these obstacles, some teachers have implemented various technology-
based solutions, one of which is videoconferencing. The majority of videoconferencing-based virtual field trip programs connect classroom students either to a distant: 1) informal science facility (museum, zoo, science center, etc.), 2) group of classroom students, or 3) science expert. This virtual field trip project, while incorporating various aspects of other similar programs, was unique with respect to two important factors. Field trips were: 1) located within the community relatively close to the school site, and 2) self-contained. That is, each field trip was produced by students for their classmates.
CHAPTER III

EQUIPMENT

Computer Hardware and Software

Videoconferencing Background/Connections/Hardware

Since 1996, there have been significant increases in not only the number of schools connected to the internet, but also the type and speed of these connections (Wells & Lewis, 2006). This has been the direct result of the federal government’s Education-Rate (E-Rate) program which considers the socioeconomic and geographic factors in a community and provides discounts to qualifying schools on internet services and infrastructure hardware. As of 2005, 99% of secondary public schools and 95% of these schools’ instructional classrooms had access to the internet (Wells & Lewis, 2006). As an eRate participant, our school site is able to maintain a sustained, high-speed internet connection of 35 megabits-per-second. This high speed internet connection provides students immediate access to a vast network of multimedia, communication and information technologies that can serve to enrich their learning experience beyond the walls of the classroom. One of these technologies is videoconferencing, the subject of this project.

Videoconferencing is defined as “a tool which allows users to see and hear the person they are communicating with” (Arnold, Cayley, & Griffith, 2002, p. 8) and can be
accomplished by two types of systems: a dedicated videoconferencing unit or an off-the-shelf personal computer using videoconferencing software. Most dedicated units utilize components which communicate via specialized telephone connections called Integrated Services Digital Network (ISDN) lines (Arnold et al., 2002). These ISDN lines allow for the simultaneous transmission of data, voice and text transmission over a common phone line. In contrast, computer-based systems transfer data from one computer to another via the internet, referred to as Internet Protocol Videoconferencing (IPV). Both types of systems have their advantages and disadvantages. Choosing between the two depends on the specific application, proposed use, and available technology infrastructure, the network connection.

Dedicated videoconferencing units are designed primarily for presentations to large-groups. While they can be mounted on a cart to provide a limited amount of mobility, they are typically installed in a room designed to host videoconferences, exclusively. Basic system components include a camera, microphone and the main hardware unit called a “codec” to encode (compress) the digital signal being sent and decode (decompress) signals being received (COder and DECoder).

Each component of the system is also available with optional features which potentially serve to make the videoconference more effective. For example, the codec can include additional ports to allow for peripheral video and/or computer connections, providing the user the ability to instantly switch between their projected image, a PowerPoint presentation and/or video from a document camera. While older units relied solely on ISDN connections, newer units are available with both ISDN and IP
videoconferencing protocols. Another advantage is that these units receive and output high-definition video signals which provides for unrivaled image quality.

The primary disadvantage of dedicated systems, however, is the high cost. Depending on features included in components, these systems can cost from $9,000 to $18,000 for a single unit (Buyer's Guide: Interactive Videoconferencing Systems, 2009). The advantage of using an ISDN line is that it relies on existing telephone infrastructure, making this type of network connection easy to deploy. However, much like today’s internet service providers, ISDN lines incur not only a monthly service charge, but a per-minute usage charge as well. With some units requiring three separate ISDN lines, a one hour videoconference can easily exceed $60 in connection costs alone (IVCi., 2007).

In comparison, internet protocol videoconferencing relies on personal computers with multi-core processors with sufficient computing power to facilitate the videoconferencing. There are two primary reasons why more users are employing this type of videoconferencing: price and availability. The equipment required for IP videoconferencing consists of a personal laptop computer with a multi-core processor and external web camera. This can be purchased from any electronics retailer for under $800, significantly less than the cost of a dedicated videoconferencing unit. The increasing availability and capacity of the internet with no per-minute usage charge also contributes to the increasing use of this approach.

To facilitate the transfer of large amounts of audio and video data, IPV systems must also use a codec to compress and decompress data between remote computers. Running within an application, these software codecs compress video and audio data on the sending end so that less information is actually delivered through the
network and over the internet. On the viewer’s computer (the receiving end), the same codec is used to *decode* the incoming data and the video picture is reconstructed on the user’s screen. Software engineers have been continually improving video and audio codec algorithms (Arnold et al., 2002). One of the latest and best video compression codecs is H.264 which is extremely efficient and has the ability to deliver high quality video with a minimal amount of data transfer.

Considering the project’s limited budget and our school site’s exceptional internet bandwidth, the approach of choice was to use personal computers to deploy an IPV system. Laptop computers were another obvious choice. Not only did the computers need to be transported to each field trip site, but once there and online, the computers and their respective video camera operators had to be able to maneuver in and around the location wirelessly. With respect to choices in computer platforms, both Windows-based and Apple computers have videoconferencing software built into their operating systems. Apple’s computers, however, use an instant messaging application called iChat AV. This America Online Instant Messaging (AIM)-compliant application uses the H.264 codec and QuickTime, another core video application on Apple computers, to deliver high quality video with a minimal amount of data transfer. Furthermore, iChat, unlike any other current videoconferencing applications, easily allows for multipoint videoconferencing in which up to four computers in different locations can see and hear each other during a single videoconferencing session. This is a significant advantage in this type of project in that multiple computers at the field trip site can offer students in the classroom up to three different viewpoints at any given moment. A total of three Apple
computers were used in the project: two smaller units for the fieldwork (MacBooks) and one, larger, more powerful computer to be stationed in the classroom (MacBook Pro).

Video Cameras

By definition, videoconferencing requires that a video signal is transferred from at least one participant during the conference. Apple’s iChat has the ability to use video from one of two sources: 1) the video camera integrated into the upper portion of the screen on all Apple laptops, or 2) a dedicated, external video camera connected to the computer via the appropriate cabling. While the integrated camera is sufficient for one-on-one videoconferencing, its does have limitations. For example, it is fixed into the bezel of the screen so different camera angles (panning, zooming) requires moving the entire laptop, which can be awkward and cumbersome.

There are a number of other reasons why external video cameras are better-suited to this type of project. Dedicated video cameras have the ability to:

- be positioned independently of the computer, allowing students to focus on different points of interest without having to manipulate the computer.
- use the telephoto lens feature to zoom into and out of a shot. Because of potential safety concerns or geographic boundaries, students will not always have the opportunity to get close to a particular object of interest.
- be adjusted to compensate for low-light conditions or manually focused for macro (extreme close-up) shots or those through a window.
- record each camera operator’s portion of the videoconference so the entire session can be later edited for viewing by another audience.
- capture audio directly to the camera/computer/tape by use of its available microphone input jack.
- have a larger video-capturing chip (CCD or “Charged Couple Device) which produces better quality video.

Video camera technology is currently undergoing a transition from standard definition video (which utilizes mini-DV tape, DVD-recordable or hard disk recording options) to high definition video cameras which use hard disk or flash-based storage. Because the quality of the video is limited by the software and network infrastructure, most any video camera will suffice for this particular project. There are some connection requirements, however. First, the camera must have a digital video output port, either Universal Serial Bus (USB) 2.0 or Firewire (IEEE 1394), which allows the camera to be connected to the computer. Also, one field camera will require a microphone input port. Audio from a wireless lavaliere microphone worn by the field trip host will be routed by a cable connection from the wireless receiver (worn by the camera operator) directly into the camera’s microphone input port. The particular camera model used in this project was the Canon ZR800, a standard-definition, mini-digital videotape (mini dv) camera which had both Firewire output and audio input ports. This camera is no longer in production. Cameras were connected to each computer using a fifteen foot length of Firewire cable.

A third option would have been to use a dedicated universal serial bus (USB) web camera (webcams). These cameras are relatively inexpensive and easy to use, provide increase mobility and a better quality picture compared to a laptop computer’s built-in camera; however, they do not have a zoom lens or a built-in view screens.
Audio Equipment

When the iChat software connection is first opened, the audio and video both default to the built-in microphone and camera, respectively. If an external video camera is attached, the audio and video input source must be changed by accessing a preference pane within the iChat software application. Audio will then be automatically routed through the external camera’s built-in microphone. This arrangement is usually adequate when the field trip site contains minimal ambient background noise and the host is relatively close to the camera. However, all of the project’s field trips significantly benefited from the use of a wireless microphone system. These 2-part systems contain a separate transmitter and receiver that send and receive audio via ultra-high frequency (UHF) radio waves over distances up to 400 feet. The host wears a wireless transmitter that powers a small lavaliere microphone clipped to their shirt. The accompanying wireless receiver is worn by the lead camera-person with the audio routed to their camera’s audio input. This type of audio system, although costly, compensates for scenarios such as:

- noisy environments in which it would be difficult, if not impossible to hear to host, such as in a manufacturing plant.
- the host is not directly facing the camera as they conduct a tour of a facility.
- safety issues requiring students to remain a secure distance from a point of interest—the host’s audio can be transmitted from a safe distance while the camera captures a video close-up using the zoom lens.

Additionally, because the field trips were interactive, students in the classroom used a dedicated, external microphone to ask questions of the field trip host.
Again, while the computer has its own built-in microphone, audio quality was significantly improved by using a dedicated USB microphone. In the classroom, the field trip’s audio feed would normally be routed through the classroom computer’s internal speakers. To increase the effectiveness of the audio for the classroom space, an audio cable from the computer’s headphone jack was connected to an external amplifier and speakers. Likewise at the field trip site, an external, battery-operated speaker was connected to one of the computers so that the host/field trip team could hear questions from the classroom.

Additional Equipment

As mentioned earlier, the iChat software is capable of facilitating a multipoint videoconference with each computer displaying a 3-pane video image of those engaged in the conference. Any participant’s own video image is displayed as a smaller inset pane while the other two participants’ video images are displayed in separate, larger panes above it. To maximize the interactive nature of the field trips, the classroom computer was connected to a video projector to allow students a better view of video from the field. Although the 2200-lumen image was bright enough to view with the lights on, students in the classroom noticed a significant improvement in picture quality (contrast) when the room was only partially lit. This reduction of ambient light in the room, however, made it difficult for the classroom video camera to capture an acceptable image of the students for the videoconference. To compensate, the exposure level of the classroom’s video camera was increased, resulting in the appearance of a much brighter environment.
Another component used in the field was a wireless router. This allowed the computers/cameras to freely roam in and around the field trip site while still maintaining the required internet connection. The specific router used for this project was the Apple Airport Extreme Base Station which utilizes the fastest wireless protocol available, 802.11n. As with any wireless device, however, the strength of the signal is negatively affected by physical obstacles (walls, wiring, etc.) as well as increased distance. The strength of the signal also has an effect on a receiving computer’s internet bandwidth: the weaker the signal, the lower the bandwidth. Therefore, it was important to situate the router in an area as close to the computers as possible. In some cases, this required connecting the router to the host’s internet port by the use of a custom fabricated, two-hundred foot, category-5 Ethernet cable.

How iChat Users “Connect”

When starting iChat for the first time, the user is guided through an initial set-up procedure to create an account and username with the America-online Instant Messenger (AIM) computer server. Assuming the computer has a connection to the Internet, users are automatically logged in and connected to the AIM server each time the iChat application is started. The purpose of this connection is to indicate to other prospective iChat users that you are online and available for videoconferencing.

It should be noted, however, that once logged in, the AIM server does not automatically broadcast your username to all other connected iChat users for two primary reasons. First, one must consider that at any given moment that the number of connected iChat users could potentially be in the hundreds, if not thousands. Maintaining a current user list this large would require a continual and significant flow of data between the
user’s personal computer and the AIM server. This would result in not only limiting available bandwidth available for videoconferencing, but consume processing power on both machines as well. The second reason is privacy. Because videoconferencing is much like a “video phone call,” most iChat users will only wish to videoconference with people they already know. Therefore, in order for any user to connect to another, at least one user must share their iChat username with the other. Just as most electronic mail applications store contact information for the user’s “friends,” iChat stores the name and username of users you know in a “Buddy List.” Once the iChat software is opened, again, the application automatically logs into the AIM server with your username and password and populates your Buddy List with other users you know that are currently using iChat and also logged in to the AIM server.

Planning

Planning each field trip was accomplished using a backwards planning approach (Appendix C). The potential dates of a specific field trip were determined by how well the field trip coordinated with the concepts of a previously established, standards-based physical science curriculum. The final date was determined by the host, served as the ending point to an established planning timeline. This timeline included aspects such as completing and filing necessary forms, permission slips and/or letters to parents (Appendix D), reserving transportation and meeting with the host to discuss content, logistics, testing the internet connection, etc.
Student Training

In the weeks preceding the first, off-campus virtual field trip, all students participated in an extensive two-week training exercise.

First, students were instructed on how to operate the video cameras. This included managing the various controls of the camera to adjust light exposure, manual focus, recording and loading/unloading of video tape. Other camera-related instruction involved correctly framing the subject, zooming/panning, and techniques used to stabilize the camera and minimize movement.

The second phase of the training involved instructing students in the use of the computers. This included:

- establishing and maintaining a wireless connection between the computer and the router.
- use of the associated iChat videoconferencing software.
- connection of the camera to the computer via the firewire cabling.

The final phase of the training provided students the opportunity to establish and conduct local videoconferences within the school site. Initially, these videoconferences occurred between students in the classroom and the training webcasting group situated in an adjacent room. Ultimately, however, each webcasting group was required to demonstrate their proficiency by completing a comprehensive virtual field trip session from one of three areas within the school campus: 1) the attendance office, 2) administration office, or 3) library media center.
CHAPTER IV

RESULTS/DATA

A total of 64 ninth-grade students participated in the project and 61 students completed a 23-question Likert scale survey administered after all field trips had been conducted (Appendix E). Student responses were entered into a spreadsheet application for summative evaluation (Figure 1). Survey questions were organized into four general categories: 1) student attitudes about the project, 2) science content associated with the project, 3) technical aspects of the project and 4) interest in further, independent learning opportunities.

There were a total of five survey items (numbers 1, 3, 7, 14 and 18) that solicited opinions about students’ feelings regarding virtual field trip project (Figure 2). Students overwhelmingly approved (86% for question #1) of the variety of science-based sites that were visited during the year, while 82% of them indicated they found the excursion in which they were a field participant, interesting and informative (question #3). Another positive effect was that 81% of students thought the virtual field trip project made science more enjoyable for them (question #7). Although slightly skewed to the positive side, students felt somewhat comfortable asking the host questions during the field trip (question #14). Equally weighted and an important consideration from an educational perspective was the idea that students would rather take several virtual field trips as compared to a single field trip attended by the entire class (question #18).
Figure 1. Results of virtual field trip summative survey.

Another six survey items (numbers 6, 9, 10, 13, 16 and 17) queried students about science content associated with the project (Figure 3). More students (88% for
Figure 2. Graphs of summative survey items: student attitude.
Figure 3. Graphs of summative survey items: science content.
question #6) thought they learned more by watching the live webcast as compared to a recorded version of the field trip. In terms of the classroom experience for question #9, 75% of the students who had remained back in the classroom felt they learned more when the host engaged them with questioning strategies during the course of the webcast. A lower percentage, 44%, felt they learned more when given a handout to complete during the field trip (question #10). Students overwhelmingly agreed (80%) that the content learned in the field trip helped them better understand associated science concepts being studied in the classroom (question #16). Additionally, 71% of the students agreed that the post field trip activities helped to reinforce the field trip content (question #17).

The next group of five items (numbers 4, 8, 11, 12 and 15) asked students about the technology involved with the project (Figure 4). On the field trips they attended, 84% of the students were either neutral or disagreed with the assertion that they were distracted by the technology and therefore, could not concentrate on the field trip itself. In feeling more confident using technology (question #8), 43% of the students agreed or strongly agreed that they felt more confident in using technology as a result of the virtual field trip project. However, an equal percentage, 42%, remained neutral about their confidence using technology. In terms of the video and audio quality (question #11), 64% of the students believed that the video was of sufficient quality to observe most of the process is being discussed, while only 46% of the students were satisfied with the audio quality. Slightly more than half, 56% of the students, felt completely comfortable being on camera and/or recorded.

The last category of items (numbers 19, 20, 21, 22 and 23) asked the students about their level of interest in further exploring any of the sites visited during the virtual
field trip project on their own and outside of class time (Figure 5). Results for Sierra Nevada Brewery and Kiwanis Chico Community Observatory were mixed with half
Figure 5. Graphs of summative survey items: interest in independent learning.

(51%) of the students indicating that they would visit on their own. Results were slightly higher (55%) for traveling to some portion of Big Chico Creek. Outcomes were highest
(66%) for the digital recording studio and working with digital audio and lowest (38%) for Orient and Flume Art Glass.

The findings suggest that the project had a positive impact on students’: 1) attitude of and interest in science, and 2) perception of knowledge gains. With regard to student interaction, the results of the survey also agree with the literature: increased interaction with the host maximizes the learning experience. However, students did not overwhelmingly indicate that they were comfortable asking the host questions during the videoconference, suggesting that any interaction must be integrated into the field trip lesson plan and encouraged by the host and/or teacher.
CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

The primary goals of this project were met. First, this project confirmed the idea that students in the field could use videoconferencing technology to connect students in the classroom to the relevant and applicable science in their own community. Secondly, the results obtained indicate that virtual field trips had a positive impact on students’ attitudes and motivation. And lastly, this project showed that students’ perception of their own learning increased.

Videoconferencing can be a viable means of connecting the classroom to the field. The last four of the six field trips (observatory, art glass studio, creek geology, and recording studio) did allow students in the classroom to interact successfully through videoconferencing with the students in the field conducting the interviews and collecting the data.

The technology involved in this project was pivotal to its success. Students not only had to be proficient in the use of the computer and related software, but they had to know how to connect and operate the hardware components, including cameras, microphones, and network, required for the videoconference. Establishing and maintaining the videoconference connection to the classroom was a key part of this project. Does the extensive use of technology interfere with the learning of those students
in the field? Student survey results indicate that the majority (84%) of the students did not find the videoconferencing technology to be a distraction and that they were able to concentrate on the field trip’s content, for the trips where they were in the field.

Today’s digital age students have been exposed to technology on a daily basis and each day it becomes more intuitive and feature-laden. This could serve as an explanation for why the equipment did not tend to present a distraction, and it could contribute to the comfort level felt by the students. If they already felt confident using technology, then survey questions #8, “The virtual field trip has made me more confident in using technology,” would not accurately measure the confidence level, it would only reflect on an increased confidence level.

Student concerns over quality video may have been associated with the operation of the camera rather than the quality of the video feed. The software coder and decoder (H.264 standard codec) used by Apple’s iChat videoconferencing client provides exceptional video quality while requiring very little internet bandwidth. This resulted in a relatively clear video feed to and from the classroom. However, correct framing of the subject, keeping the camera steady, and various other technical and safety precautions, including maintaining the correct exposure proved to be difficult for some students to master in this short period of time. For example, these cameras have the ability to automatically regulate the amount of light (exposure), but there are certain circumstances when the video picture, if under- or overexposed, must be adjusted manually on the camera and students who were not familiar with the camera could not quickly adjust. These problems will be reduced as the technology becomes more and more user friendly.
The audio quality was a greater issue than the video quality. Only 46% of the students reported satisfaction with the audio portion of the feed. This was a recurring problem that, unfortunately, was never resolved, even though several attempts were made to adjust audio levels and move microphones. Logistical issues also played a role in that it was difficult to make adjustments to the equipment in the field without being able to assess the results of those changes as they happened in the classroom. In those cases in which there was no audio connection, attempts to troubleshoot the problems were communicated through the use of mobile phones or signs held up to cameras in the field and classroom. Recordings of the field trips, while they did provide some insight as to the nature of the problems, were not reliable in determining a solution. Various equipment issues were known to have played a significant role in two of the field trips: the stream study at California State University, Chico and Orient and Flume Are Glass. In one instance, a microphone connected to a universal serious bus (USB) port on the classroom computer was found to be unreliable. Communication from the classroom to the field was conducted by holding responses written on a student whiteboard up to the classroom camera. During the first five minutes of the Orient and Flume Art Glass webcast the host, wearing the transmitter to the wireless microphone on his belt, inadvertently switched it off while reaching into his pocket.

The project also had a positive effect on students’ attitudes and motivation in science. Overall, students had favorable opinions about the success of the six field trips and were interested in learning about the science involved at that site. The variety of sites included manufacturing/business facilities (neon signs, brewery, recording studio and art glass), an observatory, and a natural setting (local creek). The nature of each field trip
allowed the students to experience the interrelatedness of concepts associated with various scientific disciplines (physical, life and/or environmental) all within the context of some larger process. Equally important was the project positive effect on students’ attitudes about science. This is supported by the survey results that 81% of the students agreed or strongly agreed that the virtual field trip project made science more enjoyable for them.

Students also indicated that the field trip they attended was interesting and informative, possibly due, in part, to the establishment of the field trip schedule before the start of the project. This provision allowed students to choose the field trip that seemed most appealing to them, thereby maximizing their interest. Some students, however, did not feel comfortable asking questions during the field trip. One possible explanation could rest in the fact that the live videoconference was simultaneously being recorded. Students, aware the recording would be posted on the website, may have been fearful of asking questions they perceived as being improper. Additionally, factors associated with the nature of the field trip and the passive manner in which some hosts delivered the content may also have affected the degree of student engagement.

Lastly, the results indicated that students’ perception of their own learning increased. Overall, the students’ feedback with regard to science content suggested students learned more when the host engaged them with questioning strategies. This outcome was readily supported in viewing the recording of the virtual field trip to Big Chico Creek (Stream Study) hosted by Dr. Rachel Teasdale, a professor of geology at California State University, Chico. That interactivity is a key component in successful videoconferencing is also supported by the literature (Greenberg, 2004). Increased
student learning is observed when information is actively processed as compared to content that was passively acquired. The videoconferencing technology is merely a tool which provides students the opportunity to remotely engage in experiential learning.

Also, as educators who recognize the importance of a sound lesson plan, Dr. Teasdale, Dr. Monet and I collaborated and designed this particular field trip. This attention to lesson organization that maximized hands on activities, student involvement, and questioning strategies throughout the videoconference was responsible for this positive result. Support for this approach is also found in a literature review on the subject of videoconferencing by Heath and Holznagel (2002). They emphasize that this teacher-to-student interaction must be included as part of the lesson and consistently encouraged by the teacher.

Students had mixed feelings with regard to completing handouts during the videoconference, however. During a post field trip discussion, some students commented that continually looking down to write on the handout served to distract them from what was happening on the screen. Others mentioned that it detracted from the experience, making it less “fun.” Although the handouts were initially implemented as another method of engaging the students, this point may be a valid one. If students were not given enough time to complete answers on the handout, it may have led to them feeling that they were missing portions of the field trip important to the understanding of later concepts.

The majority of students agreed that the field trips provided additional support in their understanding of those concepts being studied in the regular classroom curriculum. This finding agrees with the research conducted by Mackenzie and White
as well as Kern and Carpenter (1986) who found that students who actively engaged in a field experience better processed the related content, retaining it for a longer period of time and to a greater depth. Most students (71%) agreed that the post field trip activities carried out in the classroom also served to reinforce the content. According to Kisiel (2006) teachers commonly take their students on a field trip without making the necessary connections to concepts that are being studied in the classroom. Trips to the field must be reinforced, not only by introductory activities that reduce novelty, but more importantly by activities that serve as extensions to the experience. This “summary unit” is the last of Orion’s (1993) three-stage learning cycle whose goal is to take the students from concepts that are more concrete, to those that require more abstract thinking.

Field trips can be effective in extending students’ learning beyond the walls of the classroom. The field trips developed by this project are distinguished from other virtual field trips in two ways: 1) these field trips were conducted within the students’ own community and 2) these field trips were conducted by the students themselves. Local experiential learning opportunities further provide students with concrete connections to the real world and their own community. This added measure of scientific relevance is also successful in engaging, motivating and furthering students’ interest in science. Despite their advantages, however, the high financial and academic costs associated with taking field trips have become increasingly prohibitive. This project served to mitigate these obstacles by using readily available videoconferencing technology to connect the classroom to real world experiences.
REFERENCES
REFERENCES


APPENDIX A
College Preparatory Science 9 Curriculum

Fall Semester

I. Metrics, Measurement & Laboratory Skills
   - Standard metric units of measurement
   - Using dimensional analysis to make metric conversions
   - Significant digits
   - Use of laboratory equipment (balance, graduated cylinder, meter stick, etc.)
   - Proper laboratory reporting (formatting, tables, graphs, etc.)

II. Matter, Mixtures, Properties & States of Matter
   - Classification of matter
   - Types of mixtures (solutions, colloids & suspensions; homogeneous, heterogeneous)
   - Properties of matter (physical vs. chemical properties)
   - Density
   - States of Matter (Solids, Liquids & Gases)

III. Atomic Structure & Periodic Table
   - History of atomic structure (Thomson, Rutherford, etc.)
   - Subatomic Particles (protons, neutrons & electrons)
   - Electrons, Electron Configurations & Quantum theory
   - Atomic emission spectra
   - History of the Periodic Table
   - Organization of the Periodic Table (metals, nonmetals, transition metals, etc)
   - Families of atoms (chemical & physical properties)

IV. Ionic & Covalent Bonding
   - Formation of ions
   - Ionic bonding between atoms (metals, nonmetals)
   - Electroneutrality
   - Naming & properties of ionic compounds
College Preparatory Science 9 Curriculum

Spring Semester

V. Organic Chemistry
  ▪ Alkanes, Alkenes & Alkynes
  ▪ Functional groups
  ▪ Organic nomenclature
  ▪ Intermolecular forces (dispersion, dipole & hydrogen bonding)

VI. Motion
  ▪ Motion is relative
  ▪ Newton's First Law of Motion (Inertia)
  ▪ Speed, Velocity & Acceleration
  ▪ Acceleration in Freefall
  ▪ Velocity and distance calculations of objects in freefall
  ▪ Projectile Motion

VII. Forces
  ▪ Newton's Third Law of Motion (Action/Reaction)
  ▪ Newton's Second Law of Motion (F = m·a)
  ▪ Momentum
  ▪ Conservation of Momentum

VIII. Energy Transformations
  ▪ Kinetic & Potential Energy
  ▪ Work & Power
  ▪ Mechanical Advantage
  ▪ Simple Machines

IX. Waves (Light & Sound)
  ▪ Anatomy & Properties of Waves
  ▪ Wavelength, Frequency & Energy
  ▪ Electromagnetic Spectrum
  ▪ Interference
  ▪ Speed of Sound
  ▪ Binary data & digital recording
Chromatography Lab

Name: ___________________________ Date: ___________ Period: ___________

DISCUSSION
In this experiment, you’ll be using a technique called chromatography. The name comes from the Greek words chroma (color) and graph (write). The technique, developed in 1910 by Russian botanist Mikhail Tswett, was used for separating the pigments that make up plant dyes.

Most nonpermanent markers (like Crayola® markers) use inks that are made of a mixture of colored pigments dissolved in water. When the point of a marker is pressed onto the end of a strip of special chromatography paper, the water in the ink carries the pigment mixture onto the paper. After the ink dries (that is, the water evaporates) the pigment molecules remain on the paper.

When the tip of the chromatography paper is placed in a small amount of water, capillary action allows the water to travel up the paper and redissolve the dried pigments (the dot), which are then carried up the length of the strip. Different-colored pigments are carried along at different rates, however, and some travel farther and faster than others.

The rate at which a pigment is carried by the water depends on its size and polarity. When it comes to polar molecules, the rule is “like dissolves like.” That is, pigment molecules that are more polar will be more attracted to the water, which is also a polar molecule. Other less polar or non-polar pigment molecules, however, will be more attracted to the non-polar paper of the chromatography strip. Since the different pigments that were mixed to make the color all have differing polarities, they can be separated using chromatography.

MATERIALS

<table>
<thead>
<tr>
<th>chromatography strip</th>
<th>pipette with 3 mL water</th>
<th>felt-tip ink pen, brown</th>
<th>ruler</th>
</tr>
</thead>
<tbody>
<tr>
<td>test tube</td>
<td>scissors</td>
<td>150 ml beaker</td>
<td>forceps</td>
</tr>
</tbody>
</table>

PROCEDURE:
Preparing the strip:

1. Don’t handle strip with fingers, as oils will clog up pores in paper, decreasing porosity.
2. Using a pencil, mark a small dot half-way between the bottom corners of the strip.
3. Measure 1” up from the bottom-right corner of the strip and make another dot.
4. Measure another 1” up from the bottom-left corner of the strip and make another dot.
5. Use the scissors to cut from the bottom dot to each of the side dots.
   Your strip should now have a “V” at the bottom.
6. Using a Brown Crayola® marker, I will place small dots at the top of the “V” in the center of your strip.

Running the Experiment:
7. Pipette 0.5 mL (10 drops) of water into the test tube.
   Put pipette ALL the way in tube.
   Take care not to get water on sides of tube, start running from the side, not from bottom.
8. Place the test tube with water in the beaker so that it sits at an angle.
9. When instructed to do so, drop your chromatography strip (“V” end first) into test tube.
10. Record the time.
11. Record your data by drawing the strip every 5 minutes.
12. Allow the strip “to run” for 30 minutes.
13. After 30 minutes, remove the strip form the tube using forceps.
14. Write your initials on the crayola used on the strip (if it’s still the right one) and place the strip on the set of paper towels indicated by your instructor.
**DATA**

<table>
<thead>
<tr>
<th>Time (mins)</th>
<th>0</th>
<th>5</th>
<th>10</th>
<th>15</th>
<th>20</th>
<th>25</th>
<th>30</th>
</tr>
</thead>
</table>

**ANALYSIS**

1. List, in order (from the top of the strip to the bottom), the different colors that make up the color brown in the markers we investigated.

2. EXPLAIN why the colors separated as they did.

3. What can you determine from the size of each of the colored “dots” on the strip?

4. According to your data, what is the formulation (recipe) for the brown marker we investigated.
   
   Return to the lab and test your hypothesis by mixing the respective amounts of food coloring into 30mL of water. Dip a rolled up paper towel into your “brown ink” and then blot it in the circle area below. Indicate your “recipe” underneath each circle. Several circles are provided for any revisions to your hypothesis.

   ![Diagram of circles](image)

5. What could we have done to get better separation of the colors?
APPENDIX C
Virtual Field Trip Checklist

Field Trip Location: 

Date: ______________ Host: ______________

Parent Driver(s): ______________________________

Specifics/Logistics: ____________________________

2 Weeks Before Trip
☐ Van Request to District Office
☐ Field Trip Permission Slip to Principal

1 Week Before Trip
☐ Permission Slips to Students
☐ Teacher Permission Slips (class release)
☐ Email attendance office with names of traveling participants

Day of Trip
☐ MacBooks (2)
☐ MacBook Power Adapters (2)
☐ Canon ZR800 DV Cameras (2)
☐ DV Camera Power Adapters
☐ DV Tapes (5)
☐ AV Cart
☐ Student Permission Slips

☐ 100-ft Extension Cord
☐ Canon Optura 400 DV Camera
☐ Extra 9V Batteries
☐ 200ft Ethernet Cable
☐ Panasonic Digital Camera
☐ Wireless Lavaliere Microphone
☐ 1/8" Stereo Cable Connector

Field Trip Specific Items
☐ Shovels
☐ Whiteboards
☐ Whiteboard pens & erasers
☐ Tangerines

At School Site
☐ MacBook Pro 17"
☐ MacBook Pro Power Adapter
☐ Remote for Projector
☐ Camera on Tripod
☐ Projector Screen Down
☐ Leave Attendance Sheets

Connections
☐ Firewire from Camera
☐ USB from Microphone
☐ Stereo for Audio
☐ DVI for Projector

☐ Power Adapter
☐ Ethernet: Wall to MacBook Pro
☐ Set Location to "iChat"
APPENDIX D
College Preparatory Science 9
Toyota Tapestry Grant

“What’s in My Backyard? Connecting Students to Community Science”

October 24, 2007

Dear Parents or Guardians,

As you know, our two periods of College Preparatory Science 9 are involved in a virtual field trip project.

One of our initial field trips was to be centered around the concept of “Mixtures and Solutions.” Earlier in the school year I contacted two local businesses about hosting this particular trip. However, once they realized that cameras were involved they quickly declined any additional involvement.

In the course of additional discussion with students, many of them expressed an interest in visiting Sierra Nevada Brewery. While we do have a trip planned in April to see how they generate their own power using fuel cells, this additional trip would focus strictly on the scientific processes involved in the production of beer.

It is important to mention that, although not in the context of beer manufacturing, each process is already incorporated into the science curriculum here at Pleasant Valley High School.

The CPS9 classes have already discussed concepts involving mixtures and solutions and how they can be prepared and separated. Our upcoming organic chemistry unit will address simple sugars and carbohydrates. Next year in Biology, students will learn about aerobic and anaerobic respiration and how these sugars can ultimately be converted to ethanol by microorganisms. Then as Juniors in Chemistry, students will discuss the implications of using corn grain ethanol as a replacement for petroleum-based fuels.

I am sensitive to the potential concerns that some may have regarding students and their exposure to alcohol and I will formally express that I am in no way, shape or form promoting the student use of alcohol. The purpose of this letter is to provide some background about the nature of the field trip and for permission to allow your student to participate.

If you have any other questions, please contact me via e-mail at rbarber@chicousd.org or through my website at http://www.chicousd.org/rbarber.

I appreciate your time and effort in helping me make this project successful for students.

Thanks again,

Ray Barber
Science Department
Pleasant Valley High School

Student Name: __________________________________________

I have read the letter and...

☐ I will allow my CPS9 student to participate in a field trip to Sierra Nevada Brewery.

☐ I do not want my CPS9 student to participate in a field trip to Sierra Nevada Brewery.

_________________________________  _______________________
Signature of Parent or Guardian          Date
**Virtual Field Trip Summative Survey**

*Directions:* The statements in this survey have to do with your opinions, feelings and perceptions regarding the Virtual Field Trip project. Please read each statement carefully, and circle the number that best expresses your own feelings. Most importantly, BE HONEST — there are no “right” or “wrong” answers. Your responses will NOT affect your grade in the class.

<table>
<thead>
<tr>
<th></th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I liked the variety of virtual field trip locations we visited.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>2. I was able to attend the field trip I selected as my first choice.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>3. The field trip I attended was interesting and informative.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>4. On the field trip I attended, I was distracted by/concentrating on the technology and could not concentrate on the field trip itself.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>5. As a classroom observer, I was more interested in watching the other students at the field trip rather than the field trip itself.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>6. I learned more from watching the videotape of the field trip than I did from the live webcast of the field trip.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>7. The virtual field trip project made science more enjoyable for me.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>8. The virtual field trip has made me more confident in using technology.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>9. I learned more when the field trip host engaged me by asking me questions.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>10. I learned more when I was given a handout to fill out during the course of the field trip.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>11. During the webcast of the field trip, the quality of the video was good enough to observe most of the processes being discussed.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>12. During the webcast of the field trip, the quality of the audio was good enough to hear most of what was being discussed.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>13. I learned more by having another science teacher in the classroom during the field trip.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>14. I felt comfortable asking the host questions during the field trip.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>15. I felt comfortable being on camera and/or recorded.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>16. The content covered in the field trip helped me better understand some of the concepts that we were studying in class.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>17. The follow-up activities helped me better understand the content covered in the field trip.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>18. I would rather take one field trip that the entire class could attend rather than several virtual field trips.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

As a direct result of the virtual field trip project, I plan on visiting (on my own):

<table>
<thead>
<tr>
<th></th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>19. Sierra Nevada Brewery</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>20. Kiwanis Chico Community Observatory</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>21. Orient &amp; Flume Art Glass Studio</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>22. Some part of Big Chico Creek</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>23. A recording studio or working with digital audio (like Garageband)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
ADDITIONAL REFERENCES

Science teaching beyond the classroom. *SCI TEACH, 73*(1), 26-30.


Moore, S., Lilly, F., Bruce, B., & Buell, J. What Science and Technology Mean to the High School Learner: Impact of the NSF GK-12.


