Web-based Learning Tools and Techniques for Rural and Tribal Adult Learners

Final Project Report for a Master of Science in Rhetoric and Technical Communication

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1.0 Background

The United States Bureau of Indian Affairs (BIA) and the US Federal Highway Administration (FHWA) have contracted the Michigan Tech Tribal Technical Assistance Program (TTAP) to deliver training and technology to tribes throughout the Eastern and Midwestern BIA regions. These regions encompass 32 US states and 64 federally-recognized Native American tribes in areas bordering and east of the Mississippi river. Along with six other TTAPs funded by the BIA and FHWA, the FHWA and state departments of transportation (DOTs) fund a similar program that delivers training and technology to local government agencies through 51 Local Technical Assistance Programs (LTAP) in Puerto Rico and every state of the USA. The TTAP and LTAP centers are frequently located within research departments of universities, and sometimes within DOTs or other government agencies. For every TTAP and LTAP, delivering the needed training and information to end users is an increasing challenge in the face of limited funding, especially in geographically large states, and because the majority of end users are from rural agencies with limited resources. To meet the challenge of delivering quality training and information to geographically-disperse clients at low cost, TTAPs and LTAPs are exploring and implementing new technologies and practices based on information technologies, including Internet-based information distribution, distance education, and e-learning systems.

This project investigates the state of the practice and issues surrounding the use of e-learning and distance education technologies and makes recommendations for using these technologies to accomplish the goals set out in the Michigan Tech TTAP contract with the Federal Government. The lessons learned from this investigation contribute to the recommended design of on-line courses and the accompanying Distance Ed and E-Learning Guide for Local and Tribal Technical Assistance Programs. The Guide will be offered to LTAP/TTAP centers to help them efficiently meet their customers' training and education needs. The Guide examines existing technologies which may quickly become outdated, but the general information on the issues and the tips on creating an on-line course will remain relevant regardless of the technology used.

2.0 Current Training Practices

TTAP organizes, creates, and delivers specialized training relevant to transportation infrastructure development, management, and support in Native American communities. This training includes workshops and classes spanning one to fourteen days on subjects such as heavy equipment operation and safety, erosion control, surveying, traffic counting, traffic safety, welding and welding safety, Public Law 93-638 (Indian Self-Determination and Education Assistance Act), transportation planning, geographic information system use, and others. Students are adults with varying education levels, from sub-high-school graduates through all levels of university graduates. The occupations vary through the entire range of skilled, unskilled, and professional workers, including occupations such as construction workers, equipment operators, government leaders, public sector employees, planners, engineers, and academics. Students attend TTAP and LTAP classes to improve or acquire new job skills, train in new technologies and techniques, as part of required safety and skills maintenance, or out of general interest. TTAPs and LTAPs have traditionally organized classes and field instruction for groups of one to more than 50 students, sending either employees or consultants to a community where the students gather in a local facility. TTAP/LTAP employees may micro-manage the workshop organization and delivery when hiring an outside consultant, or consultants may provide varying levels of workshop management, up to and including fully self-managed/delivered.

2.1 Benefits and Challenges of Current Training Practices

Current training practices are very effective and continue to be highly-valued by TTAP/LTAP customers and funding agencies. TTAP/LTAP centers share resources whenever possible to increase overall program efficiency and to increase the depth and scope of instruction without increasing redundancy throughout the TTAP/LTAP community. Based on surveys and feedback from face-to-face workshop participants, the face-to-face training is highly valued by students and they prefer this training to other forms (Representative LTAP/TTAP User Evaluations 2007). In spite of the effectiveness and preference for current practices, TTAP/LTAP centers cannot deliver adequate training with existing resources. A center such as Michigan Tech TTAP

which covers 32 states and 64 tribes with three full-time employees cannot reach every community in a calendar year with current budget constraints. The situation is not significantly different for state LTAPs: Most centers have fewer than five full-time employees and are tasked with supporting every county, city, town, village, and some state agencies (National LTAP/TTAP 2007). To help disseminate training and information, the centers do distribute training and informational materials as "self-taught" courses, and these generally take the form of videos, manuals, flyers, and bulletins. These self-taught course materials are often used in conjunction with local training by instructor, as refreshers to other classes, or on their own.

3.0 Proposed Solution for Broader Distribution of Training

To help alleviate the problem of delivering training to a geographically disperse client base with limited resources, I investigated distance ed/e-learning and electronic technologies to supplement and add to our regular course offerings. This paper describes the evaluation process from technical, pedagogical, administrative, and financial perspectives. The evaluation contributes to the *Web Based Learning Wiki* at <http://www.velat.org/web-based_learning>, which is a dynamic resource for the LTAP/TTAP community to learn from and contribute to.

3.1 Recorded/Printed Materials

Printed education materials remain a key component of nearly every educational endeavor. For the purposes of this paper, "printed" will refer to materials distributed on paper as well as written instructions available via electronic distribution. "Printed" materials also cross into the realm of multi-media training materials such as videos, animations, hypertext, and audio. Centers such as the Michigan Tech TTAP and Michigan LTAP distribute hundreds of copies of printed and multimedia materials each year, and these materials remain in high demand. These materials can and should be used together with Web-based learning tools. The discussion of how to use printed materials is discussed in Chapter 5. Evaluation of printed materials is not within the scope of this project.

3.2 Distance Education and Electronic Information Distribution Methods

Teachers and institutions seeking to extend their reach to remote students have pressed emerging communications technologies into service soon after their invention. Printed books taught Buddhism through the words of block-printed scriptures during 1400 years ago (Contributors 2007) (The Open University, BBC 2005), and radio was adopted as early as 1917 to teach (Miller and Cruce 2006). Television, film, audio recordings, and many other commercial and non-commercial communications networks were quickly adopted to teach remote students, and the use of the Internet to teach continues this tradition.

"Distance" education might be interpreted as any instruction that takes place at a "distance" from a traditional classroom. Much of the current LTAP/TTAP training takes place as "distance education": Trainers travel to student locations and deliver instruction at the students' place of work. In addition, LTAP/TTAP centers mail or offer for download information and training materials for students to learn on their own without direct instructor/student interaction. Some courses are also offered in combination with mailed/downloaded materials to be used with face-to-face training.

3.2.1 Distance Ed, E-Learning, Web-Based, and Internet-Based Learning

E-Learning, Distance Learning, Distance Ed(ucation), and Web-Based Learning are often used interchangeably. E-Learning refers to any teaching/learning technology that uses electronic media, e.g. television, radio, multi-media, and Web-based, but this project concentrates on teaching and learning where the student and teacher communicate primarily via Web-based and telephone technologies. The lessons observed in this project might be live, as in a Web-based conference; or it might be "on-demand," i.e. recorded, printed, or multimedia, but not received at the same time as the teacher is delivering or creating the instruction. I will also briefly examine alternatives to Web-based distance education, such as closed-circuit television networks, but we did not try these alternatives due to cost and other constraints, which I will also discuss.

3.2.1.1 Accessibility

The proliferation of computers and Internet access is giving more teachers and learners access to each other via inexpensive, high-speed networks. Just 10 years ago (mid 1990s), an Internet connection was considered "fast" if it was made via a dial-up modem operating at 33-56kbit/s. At that time, "high-speed" Internet connections were generally less than 128kbit/s. The availability and cost of any kind of Internet connection just eight years ago severely limited access to Internet-based resources, with just 10% of US Internet users having regular access to high-speed Internet in 1999 (Website Optimization, LLC 2003). In 1997, a 112kbit/s US ISDN connection cost $250/month (Hanrahan 1997), and availability was limited to major metropolitan

areas. Today (2007), DSL, cable, and other technologies can deliver 384-3000kbit/s and faster Internet access at prices as lows near $20/month in rural and metropolitan areas. Along with home-based high-speed Internet access, most workers now regularly use networked computers at work (Website Optimization, LLC 2007).

Today's web-based multimedia tools are generally not even recommended to be used over modems, and our own research found that most tools work best when connection speeds are well over 128kbit/s duplex (upload and download speeds). In addition, with access to high-speed Internet in over 50% of US households and 30% of households worldwide (Website Optimization, LLC 2007), both teachers and students have more places to connect even if their workplaces do not allow or do not have access to the Internet. This prolific access to high-speed networks allows teachers to use tools that deliver rich media to users geographically distant, physically unable, or otherwise prevented from attending face-to-face lessons.

3.2.1.2 Technologies

Technologies available for distance education include closed-circuit television networks, Internet-based networks, telephone networks, and hybrids using two or more communications media.

3.2.1.2.1 Television

Closed circuit television networks are a well-tested and successful method of delivering high-quality, media-rich content. Universities, schools, governments and businesses have been using video networks for over 50 years, both in open broadcast mode and closed circuit mode. Closed circuit video networks allow fully synchronous connections of both voice and video, as well as asynchronous "broadcasting" similar to commercial television. The advantages of dedicated video networks include high reliability, high quality, a familiar interface, and controlled interaction. The disadvantages include high capital cost, high usage costs, limited access, limited interactivity, and controlled interaction. In this study, we did not choose to evaluate the effectiveness of video-network based instruction because these networks did not meet the desired qualities of low-cost and high-accessibility. Other researchers have studied video-network based

instruction at length, and some affiliate organizations are successfully using this technology to deliver training to audiences similar to our own (New Training and Technology Transfer Methods in Distance Learning 2006).

3.2.1.2.2 Telephony

Telephone networks are another well-tested and successful method of delivering high-quality, media-rich content, and modern telephony can be leveraged to deliver similar content without the accessibility limitations of video networks. Telephone networks can also deliver Internet content. In our study, we used telephone networks to create additional reliability and communications quality, as well as to deliver Internet content. The advantages of telephone-based instruction are low cost, high availability, familiar interface, and proliferation. With modern cellular networks, telephony is extending the capabilities of instruction via telephone into the field and with ever increasing media richness. Telephone- based instruction drawbacks, such as low fidelity, low media content, uncontrolled interaction, and low access controls, can be overcome with additional devices and programming. Devices and programming which reduce telephony drawbacks increase its complexity and make the telephone more like the computer-based learning discussed in this paper.

3.2.1.2.3 Web/Internet-Based

We chose to examine Web-based distance education technologies because they can overcome the drawbacks of dedicated video networks and telephone networks while delivering the same qualities of those technologies, qualities that make them useful communication tools for teaching and learning. Computer-based technologies also give instructors and learners many tools to enhance the learning process, tools which are difficult or impossible to implement over voice and video networks. We did find that computer and Internet technologies can be unreliable and difficult to use (see Section 5.0: Teaching Techniques and Issues for On-line Learning), but with the proliferation of computers, high-speed Internet access, and computer literacy, we expect computer technologies to become increasingly acceptable and capable tools for teaching and learning.

The advantages to computer-based instruction and learning include high-accessibility, high-quality, media-rich content, high interactivity, increasingly familiar interface, and highly controllable interaction. The disadvantages include an unfamiliar interface for large portions of the population, highly uncontrolled interaction, "technophobia," "gadget mania," and unreliability.

3.2.1.2.4 Hybrid

Hybrid systems use a combination of electronic and/or printed materials to augment each other or increase reliability. After several trials using Web-based media clients with fully-integrated video and audio with mediocre results, I decided to avoid video when possible, and move the audio portion to a telephone conference. Disabling the video and audio streams significantly reduced bandwidth requirements, and audio on the telephone network was nearly 100% reliable and of good fidelity.

Hybrid systems are not the same s as "blended" learning systems. Blended systems use several teaching/learning formats to deliver lessons, e.g. a course combining face-to-face classes, followed by on-line meetings, recorded materials, and/or printed materials. Hybrid systems combine multiple technologies simultaneously to deliver one lesson.

4.0 Evaluating Web-based Distance Ed Tools

After deciding to use Web-based tools to deliver training and information, I investigated several software and hardware solutions from a range of criteria found in Table 4-1: List of Criteria Used to Evaluate Web-Based Learning Tools. The criteria emerged through successful and unsuccessful trials of various technologies and products. The goals of these evaluations were to select an appropriate tool for conducting Web-based training, and to evaluate the features and problems that contribute to useful tools. Although these evaluations do lead to selection of one product for further use by the Michigan LTAP and TTAP, the product itself is irrelevant.

The evaluation method is useful for judging any distance education technology. At the rapid pace of change in the instructional technologies marketplace, the software and hardware mentioned here may be completely forgotten in a short time. I mention the software package names in order for others to identify possible providers and to allow re-evaluation of new versions to determine if deficiencies have been addressed through programming or increased system-wide capabilities and performance. Given the primary constraints of cost and availability, I narrowed the classroom test field to three systems and several brief reviews of competing products which I could not use in a classroom setting.

These criteria were selected based on evaluations of students and student-accessible technology and on TTAPs resources. As a pilot project with no outside financial support, the cost needed to be near zero for students and the organizing institution. This lack of financial support also contributed to the technical constraints. With greater financial resources, technical expertise might be hired, and licensing costs might be less restrictive, increasing the field of technologies available to deliver training to remote students.

Table 4-1: List of Criteria Used to Evaluate Web-Based Learning Tools

1. Low cost	The TTAP and LTAP programs have very limited funding, so the system should be as inexpensive as possible
2. Ease of student-side installation	Students may have very limited computer experience, and because they are remote, little support, so the installation of any software or hardware should be as simple as possible

3. Richness of media interface	These systems should allow communication of information that is difficult or impossible to do with existing media, so the richness of content should be greater than current technologies such as DVD, printed materials, and Web pages
4. Availability to instructors and clients (lack of license restrictions)	Because students and instructors will be from many different organizations and perhaps only attending or giving instruction one time using this medium, licensing should be flexible and low-cost.
5. Ability to function across and through "secured" networks	Because the users' environments include places like offices, homes, hotels, and universities, and security measures vary greatly in these places, the software should work even when a user's network is secured by network administrators by devices such as firewalls, filters, and traffic shapers.
6. Student and teacher manageability	The software should allow configuration and manageability by students and teachers without extensive support from technical specialists
7. Technical expertise needed to implement	Users should not need extensive training to install the software and local technicians should be able to understand and support the software installation.
8. Technical expertise available to assist	Technical support staff should be available to help with configuration and use.
9. Desirable features	
a. Sessions can be recorded for later playback	Instructors and students frequently ask for recordings of presentations. Recording should be built-in and easy to distribute.
b. Audio integrated	The software should have built-in audio playback and synchronous voice communication to allow both presentation of information via audio and voice communication between users.
c. Video integrated	The software should have built-in video and still-photo transmission, preferably synchronous to increase user "presence" and allow demonstration of material that cannot be described with audio.
d. Polling/surveying/quizzing integrated	The software should have built-in polling to conduct polls, surveys, and quizzes.
e. LMS integration possible	The software should be able to be integrated into a Learning Management System.

4.1.1 Technology test design

To test the candidate products, I procured the necessary devices and arranged with Dr. Bernard Alkire and Dr. William Sproule to simulcast a training to take place in Minnesota at a tribal conference center. Testing the equipment required two "technicians" and at least one remote instructor willing to be broadcast over the Internet. Dr. Alkire volunteered to set up and monitor the equipment in Minnesota, so we assembled the necessary equipment and conducted some trials on the Michigan Tech campus to train the remote "technician" and test the equipment.

Figure 4-1: Schematic of a Remote Classroom Test with MTU-Based Web Conferencing Server shows how the trial remote classroom was tested on MTU's campus.

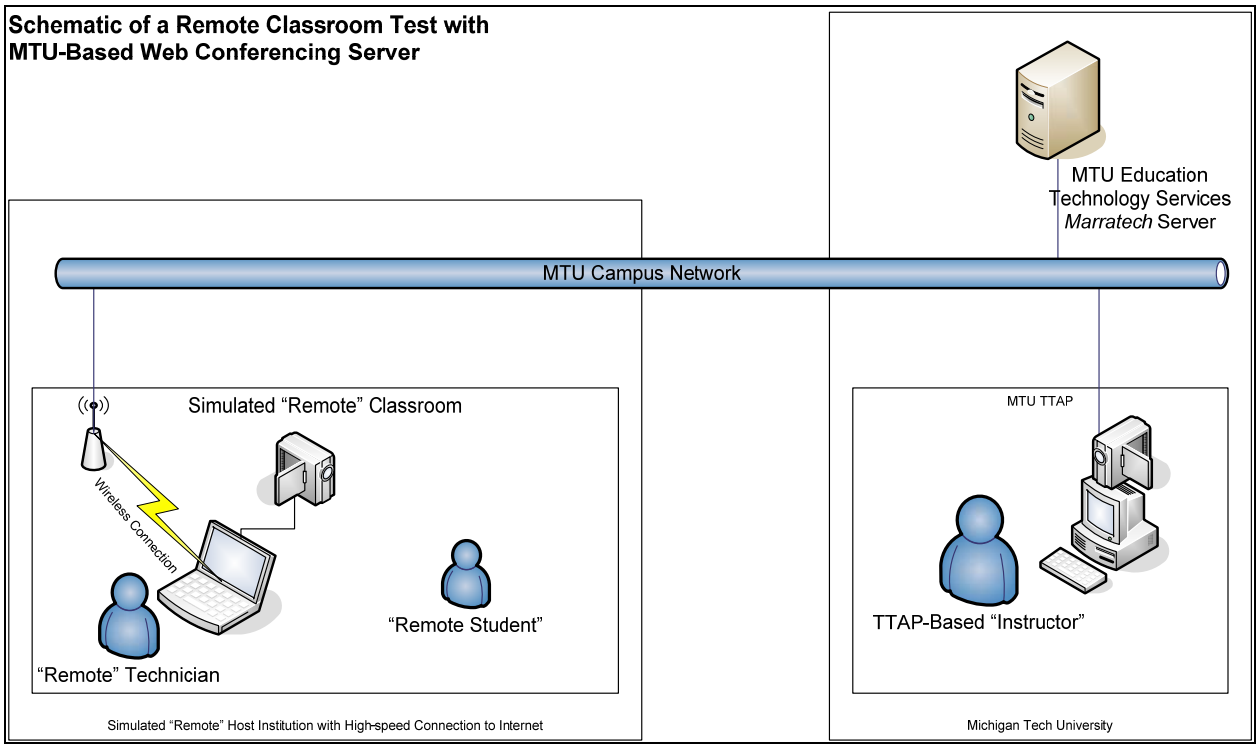

Figure 4-1: Schematic of a Remote Classroom Test with MTU-Based Web Conferencing Server

On each participating workstation, I installed the client software, Web cam and audio headset.

Figure 4-2: Schematic of Devices Required or Optional for Web Conferencing shows how workstations are setup.

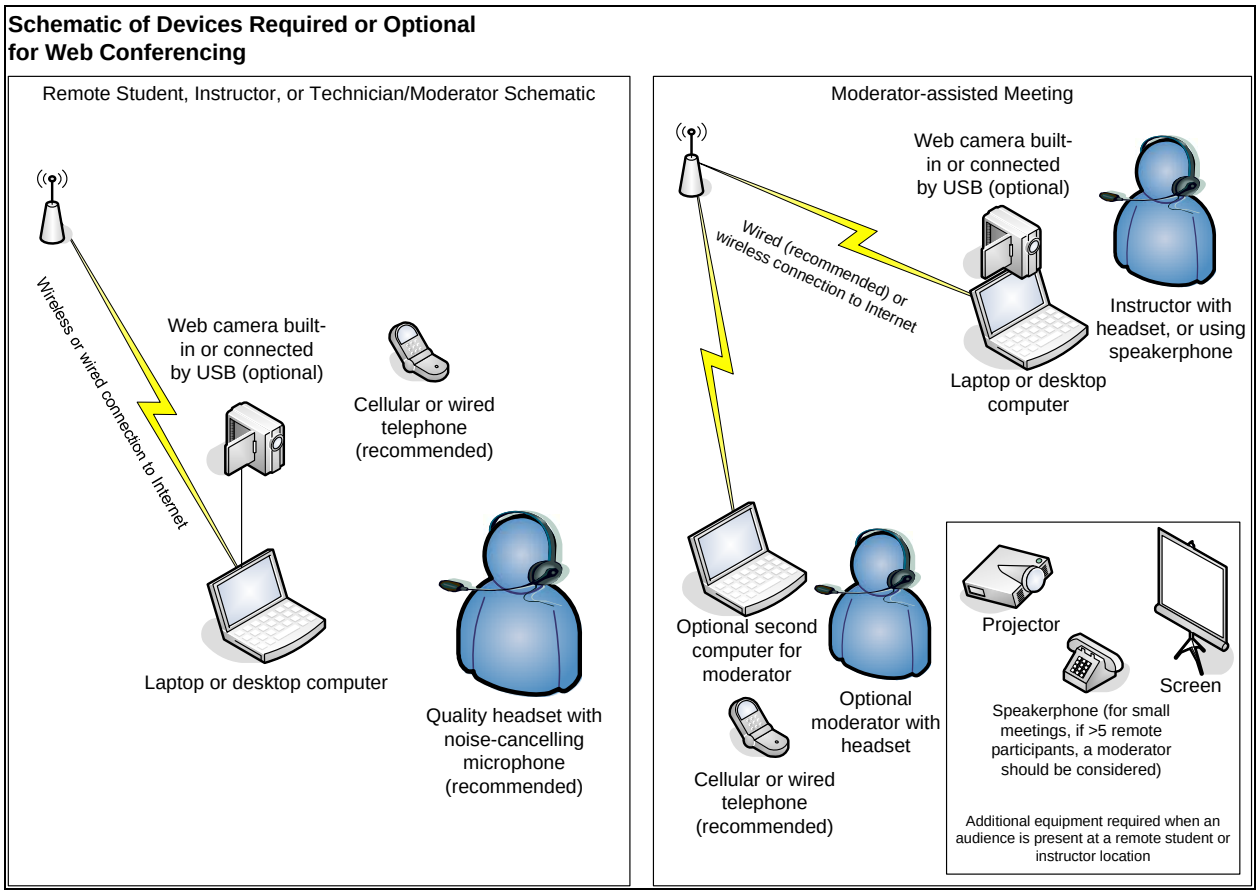

Figure 4-2: Schematic of Devices Required or Optional for Web Conferencing

An important consideration for good voice communication is the amount of time it takes for an encoded voice transmission to arrive at the receiver. Anyone familiar with using satellite communication or Voice Over Internet Protocol (VOIP) services has had to cope with echoes and delays in a voice conversation. As the delay, or latency increases, two-way communication becomes more difficult. At latencies greater than one half second, a conversation becomes more like a ham radio broadcast than a telephone conversation. Because Internet traffic is not circuit-based, the Internet connection does not establish a dedicated channel between sender and receiver, rather emphasizing error correction to ensure the message arrives intact. For a bank, this is good news, because a financial message has a high likelihood of arriving exactly as it was sent, but for a Web conference participant, a live voice message becomes distorted, delayed, or completely interrupted. Latency becomes even more problematic when the instructor is showing something

on screen and talking about what appears on that screen. In this situation, the voice description can become unsynchronized with whatever the presenter is showing, making it difficult for participants to understand the complete message.

Although most Web-based learning software offers an audio feature, field tests showed that the audio rapidly degrades when the network connection deteriorates. For those with good hearing, an interruption or delay in audio often makes communication difficult or impossible, but degraded video or visuals tend to become a mere distraction. Field tests with a dedicated phone connection between participants significantly increased the overall meeting quality and flow. In addition, the parallel communication channel helps ensure continuity should the computer or network fail. Field tests showed that meetings continued when audio continued, even when the computer-transmitted images completely failed, but when audio failed or significantly deteriorated, the meeting was interrupted or completely stopped. When all meeting participants have access to very high speed networks and very good connections between those networks, the voice features did work reasonably well.

Each product tested and the summarized results of testing for this project are described in Appendix A, Web-based Learning Tool Evaluations.

5.0 Teaching Techniques and Issues for On-line Learning

5.1 Preparation

Preparing for an on-line class shares concepts with any other class: The instructor must understand the material he or she plans to deliver, develop a plan to deliver the material, determine if and how the students should be evaluated, create content for distribution to the students, and consider how the instructor and course should be evaluated and the lesson modified to reflect unexpected outcomes. In addition to the "traditional" preparation, an instructor must learn to use the equipment, systems, and networks that will transmit the lesson materials and assist instructor and audience interaction. As the software and hardware for on-line communication becomes more commonplace on instructors' desks, the preparation time for using these tools is decreasing. I found that most students were already prepared to receive the lessons via their regular workstations, but if a lesson is to be delivered to students who do not use computers on a regular basis, part of the lesson may include teaching students how to use the communication medium.

Many on-line lessons share content with face-to-face teaching environments, and we explored a range of lesson types, from direct simulcast of a classroom lesson to carefully scripted on-line productions intended for live participation via web-conferencing software. For an instructor, the easiest on-line lesson may be a simulcast, where he or she simply stands in front of a class and delivers a familiar lesson, but is simultaneously broadcast to remote students. In the simulcast scenario, the instructor may need a moderator to help remote students participate in the class and ensure that the classroom content is adequately broadcast to the remote audience. As a lesson progresses more and more toward an on-line-only medium, the instructor should modify his or her content to fit the particular demands of the on-line environment. See sections 5.4 through 5.6 to see some issues associated with on-line lesson delivery to understand what problems on-line teachers and learners face and how those problems might be addressed. Also see section 4.0, Evaluating Web-based Distance Ed Tools, to see how specific products can be used to deliver your content.

5.2 Content

On-line and off-line content are converging as instructors increasingly prepare their course materials on computers. Common content preparation and presentation tools such as *PowerPoint*, *Flash*, HTML, *Word*, and *Acrobat* work both in the off-line and on-line environments. The exact content development tool is not important, so long as the developer can deliver a high-quality product that meets instructors' pedagogical goals. As with the choice of distribution medium, the development process and tools must take into account the audience and environment where the end product will be used.

A common content development pitfall is to try new tools or media unfamiliar to the instructor. When a developer attempts to force unfamiliar content types and tools into an instructor's curriculum, or an instructor attempts to learn new development processes at the last minute, the student is sure to suffer the consequences. The content development process must be well-planned, practiced, and the final product must undergo review long before it appears in the classroom.

Students may also be challenged by the content type because of their educational background, experience, culture, physical abilities, or other factors. The content developer and instructor must take all factors into account during the lesson planning process to ensure students are not overwhelmed by the learning process.

In the case of our own trials with new media and technologies, we warned students and instructors that they were participating in experimental lessons and sought their feedback to improve on the entire lesson, including the content itself. At each step of a lesson development, we sought to minimize the impact of learning new content development products and delivery means by selecting tools familiar to the students, instructors, and developers. When new tools and practices were necessary, the developers and instructors spent considerable time learning and practicing their production and delivery, helping ensure a smooth classroom experience for the students. We also prepared contingency plans for every lesson, including redundant communications links, multiple copies of lesson materials in alternative formats, and alternate schedules to repeat an entire lesson.

5.3 Implementation

Rolling out each lesson requires extensive preparation and practice, and the first several lessons will be daunting. Being aware of the issues and solutions in the following sections will help instructors avoid many of the pitfalls that others have already faced. The accompanying *Web Based Learning Wiki* at http://www.velat.org/web-based_learning takes you through the technical steps necessary to work with *Adobe Acrobat Connect*, the delivery tool that the Michigan LTAP and TTAP successfully implemented during this project. As this tool changes and others become available, the exact steps will change, but the basic concepts and issues related to distance education remain the same. Focusing on the lesson goals and understanding the human factors involved when teaching and learning will help overcome any technical issues that may arise. Following are specific technical and organizational issues that all distance-ed teachers, developers, and students will face. Section 6.0, Pedagogical Factors, looks at the learning process and theoretical environment of a distance-ed curriculum.

5.4 Issues: Poor Audio

Students and instructors had the most difficulty participating in the web-based training whenever audio performance suffered. In several instances, visual components of the training became distorted or missing, but if the audio component remained good, students continued to participate and sometimes did not even notice the lack of visual content. Audio communication could be disrupted by the communications channel, poor equipment, and/or interference from participants.

5.4.1 Poor Audio Example

In this example, <http://www.velat.org/web-based_learning/audio_problems>, we are conducting an on-line workshop to train users how to use custom software. Instructors and participants used telephone conferencing services to participate in the audio portion of this workshop. The visual portions were transmitted using the *Adobe Acrobat Connect* system.

In the example, <http://www.velat.org/web-based_learning/audio_problems>, students called in to the telephone conferencing service and joined as general participants who sent and received audio using their telephones. The teleconference service allows for instantaneous participation by

any participant, but also allows unregulated interference from those participants. One caller in the group of participants did not mute his or her telephone, and began transmitting the radio playing in his or her office. The radio drowned out the instructor's voice and stopped any progress in the workshop. It was impossible to determine the source of the interference without disconnecting all participants.

5.4.2 Solutions to Poor Audio

We quickly determined that a crucial component of a successful meeting or training was to have high quality and highly reliable audio connections. For this reason, we did not pursue the option of using the built-in audio features of conferencing software for live meetings unless a telephone connection was impossible or exorbitantly expensive. We also sought audio options that allowed greater control over audience participation so that a participant could not interrupt the entire workshop with unexpected background noise.

With many teleconferencing systems, there are controls which allow muting of some or all participants in the call. Some web-conferencing systems integrate these controls into the software interface, and show which callers are talking, muted, or waiting to ask a question. Without controls built into the software or teleconferencing system, the presenters must be very explicit about the rules for participation at the beginning of the call. When fewer than 10 participants are in a meeting, teleconference etiquette may be adequate to control the flow of information, but as the number of participants increases, the need for technical controls over audience participation increases.

We also improved audio performance by carefully selecting the equipment and environment for presenters and participants. For presenters, we arranged a room so that multiple presenters would all see each other. This allows the presenters to use each others' visual cues to indicate transition between multiple presenters. In addition to one workstation per presenter, we connected another computer as a "monitor" so that presenters could see how information was being received by students. A moderator could use this monitoring workstation to help answer questions and solve technical problems on-the-fly. We turned off unused telephones and locked and posted the door to prevent random visitors. Instructors used high-quality noise-cancelling headphones or

speakerphones to ensure good fidelity at the source. One benefit of using a quality speakerphone is that the presenters are not encumbered by wires and it's easy to regulate the volume between speakers by simply raising or lowering your voice to match the previous speaker. Students also maximize their experience by eliminating distractions and using a speakerphone or headset with a manual mute button.

5.5 Issues: Distractions

As noted in the audio issues section, distractions can affect the entire workshop. For presenters, it is easier to focus on the task on hand, with this exception: The seemingly endless new gadgets and software features needed to produce and manage a workshop on-line can distract the best teachers and bring their delivery to a standstill. The list of "gadgets" and features involved in a web-based training include:

- Recording software
- Chat window
- Video window
- Whiteboard
- Web browser
- Attendee list
- Instant polling
- Webcam
- Dual monitors to show multiple content streams
- Headset
- Internet connection
- Presenting software
- Presenter's computer
- Moderator/monitor's computer
- Cords to connect computers to telephone, Webcam, headphones, Internet, power, monitors, mouse, keyboards, projectors…

And when a live audience is also present,

- Projector
- Projection screen
- Audio amplifier
- Mixing board
- Speaker phone
- Remote mouse
- Laser pointer…

Aside from extensive testing and evaluation of the gadgets and features and their capabilities, a presenter needs to evaluate if and how to use these features and gadgets. Small, ad-hoc meetings might not need as many tools, because the participants may tolerate the need to repeat a misunderstood sentence or wait for a presentation to load. As the number of participants increases, the tolerance for technical difficulties decreases, but the need for more gadgets and features increases.

In addition to the technical distractions for presenters and participants, the presenter must overcome or control audience distractions. One of the greatest advantages of a web conference is the possibility of attending a meeting from your regular work place, which is also one of the greatest disadvantages. While the participants may save travel time and expense, they have not left their daily lives at work as they would if they travelled to a remote site for the workshop. Participants may be interrupted by phone calls, web browsers, e-mails, instant messages, colleagues, or a trip to the restroom.

5.5.1 Solutions to Distractions

For larger meetings, presenters will find it much easier to hand off almost all of the meeting production to a moderator or assistant so that the presenter only needs to worry about the presentation. This is particularly relevant when the presenter is expected to deliver information to a live local audience in addition to remote audiences. When presenting simultaneously to a local and remote audience, the instructor will have to decide whether to interrupt the local audience when communication problems with the remote audience occur. The instructor may choose to continue the local delivery at the expense of losing continuous delivery to remote audiences. In

this case, the instructor should plan on recording the entire lesson in case it needs to be distributed among those who missed the lecture due to technical difficulties. Even in cases of remote-only audiences, the instructor will have to decide whether to interrupt the entire lesson for technical problems and how many audience members must be affected by a technical problem before interrupting the remaining audience.

To overcome the participant distractions, an instructor can use the same techniques as he or she would use in live classroom: Engage the audience with relevant and interesting information in a cohesive manner. The additional tools available in a Web conferencing environment that are not easily implemented in a classroom, such as instant polling, chat, and sharing external materials, can all be used to encourage attention. Web conferencing platforms that provide live video feeds of presenter and students can dramatically increase audience attention. The instructor's video presence increases the connection between student and teacher, and students will also find it more difficult to ignore the instructor if they know that their video feed is being transmitted live to all participants.

5.6 Issues: Poor Delivery Methods and Styles

A Web-based medium will not make a poor teacher good, and can very well make a good teacher poor. The first problem of on-line information delivery is keeping the audience engaged long enough to cover a topic. Besides the distractions listed above, the teacher must overcome the remoteness and reduced fidelity of a long-distance connection to his or her students. Content must therefore be well-prepared for on-line delivery and the additional features of a web-based system used wisely. Instant polling and quizzes can engage an audience, but it can also disrupt an audience's concentration on the materials delivered before and after the quiz.

This brings up the second problem of on-line delivery: The difficulty of gauging an audience's attention and understanding of presented materials. For example, it is very easy to switch between materials and presenters in an on-line environment, but very difficult to gauge the audience's ability to follow these transitions. In a classroom, it's easy to see the sleeping student, but unless

the student is being transmitted live via a webcam, the instructor will have difficulty determining if one, or all of the students in remote classrooms are sleeping.

5.6.1 Solutions to Poor Delivery Methods and Styles

Just as with face-to-face teaching, on-line teaching requires preparation and practice to ensure students are engaged and understand the material. On-line teaching also shares principles of television and radio production from both technical and artistic aspects. To create engaging live and on-demand on-line instruction, we used techniques and technology from the broadcast industry and practices that good teachers use to deliver engaging lectures and classes.

One method of improving the delivery of information was simply to hire professionals from radio or television studios to produce the module. This is particularly effective for on-demand training modules. Professional narrators and video producers use professional equipment to produce the materials and have learned how to deliver material in a clear and effective manner.

Some voices and speaking mannerisms are easier for particular audiences to understand than the author's voice. For example, when an author has a strong accent or dialect to which the audience may not be accustomed, or an author is simply not accustomed to the speaking style which is well received in an audio-only medium, a professional "radio voice" may significantly improve the audience experience. We also found that professional narrators required significantly less time to narrate an on-demand module than some academics required to narrate the same material.

Another technique borrowed from radio and television production was to develop scripts and storyboards for lessons. Scripted lessons proved particularly effective at ensuring all the intended content was delivered in a restricted time frame, and the scripts also helped multiple speakers keep on track as they transitioned between topics and content. We also delivered scripted scenarios to our audience to help them understand how to apply the content in their work. For example, when we instructed students to conduct data collection in the field, instructors created a script of a "field data collection" session, simulating their trip into the field with sounds, pictures, and dialog that one would encounter in the field. This simulation proved so effective that some students admitted that they thought the instructors had actually left the office and were delivering

part of their lesson from a moving vehicle. A recording of this simulation can be viewed at <http://www.velat.org/web-based_learning/scenario_example>.

Our experience showed that on-line workshops should be kept as short as possible. Workshops over one hour may be too long for most participants and subject matter. Students may be accustomed to listening to a 60 minute lecture face-to-face, but the same lecture delivered on-line is likely to lose most participants to distractions and competing demands on their time. To keep a participant's attention, presenters should carefully plan their presentation to include adequate pauses for the audience to absorb the information, and to be sure that all participants can successfully receive the uploaded materials. When a workshop extends beyond 20-30 minutes, a presenter should consider splitting the delivery to more than one speaker. Switching speakers also gives presenters an opportunity to catch up with questions that may have been posted to the chat area during the presentation.

As with any lesson, on-line lessons must allow for audience participation. The tools available to an on-line audience help students ask questions whenever they feel the need, but time should also be given for students to consider the material and react to instructor prompts. When an on-line workshop jumps from presentation to instant poll to quiz to presentation, a student may feel overwhelmed and not be able to reflect on previous content before the instructor has moved on to new topics. The ability to pose questions at will through a chat interface can also lead to instructor distraction, or one question posed by a participant may be quickly moved off screen as additional questions and comments are posted. These are yet more reasons to be sure a second instructor or moderator is available to monitor and answer questions and audience participation throughout a lesson.

6.0 Pedagogical Factors

The organizational and logistical benefits of distance learning tend to be what drive development of e-learning technologies: More information can be distributed to more people more often, with greater flexibility. For an LTAP or TTAP, overcoming geographical barriers is generally the greatest consideration for adopting distance learning. Other important opportunities such as reaching home-bound learners, increasing the scope and speed of technical assistance, and expanding access to experts are also considerations. With such compelling benefits, the learners and instructors often overlook the implications to learning and teaching that technology and distance have. Ignoring the pedagogical implications of distance learning can lead to decreased training effectiveness, frustration by teacher and learner, degradation of an organization's value to its clients, and increased overall cost without corresponding benefit. Many organizations and learners have tried distance learning technologies only to give up on it when they face problems or don't achieve expected educational outcomes. When technology adopters fail to consider the implications of that technology, the technology may become a hindrance rather than an asset.

Pedagogical factors involved in distance learning are often considered "issues" similar to the technical and organizational issues listed previously. Pedagogical factors *are* problematic because the instructors and students struggle to overcome the technological issues associated with distance learning in order to teach and learn. When the similarities between distance and face-to-face learning are not considered with their corresponding differences in the two mediums, the distance learning format can interrupt the learning process.

For example, students and instructors "present" in a distance learning classroom are not present in the same way they are in face-to-face classrooms. Although the student may be in attendance at a remote site, the instructor and student may fail to connect with each other using the verbal and nonverbal cues associated with being physically in the same place. In an attempt to overcome this remoteness, distance learning technologies implement video, audio, and text communication channels that mimic or augment physical closeness of students and teachers in a classroom environment. The latest videoconferencing systems are clearly attempting to mimic the physical presence of a face-to-face meeting by delivering ever higher video fidelity and size

across the electronic divide (LifeSize Communications, 2007), but the benefit of this ever increasing bandwidth use and fidelity may not address the core issues that make distance learning different than face-to-face learning.

The latest videoconferencing systems recreate a face to face meeting as close as possible to the "real thing," even going so far as inserting half of an identical table on each side of the video divide, and projecting a life-size video image onto a wall-size video screen. In spite of these technological feats, the problem of presence of each participant will never be overcome in this way. For rural and tribal audiences, the equipment and communications channel costs for such a system are also prohibitive.

Hsu and Bruce address this issue of presence and distance vs. face-to-face interaction by examining the role of "borders," or genre elements, that frame our understanding of an interaction via a given medium. In distance education, the borders are blurred by technological crutches, but the crutches never completely support the full interaction two or more people are capable of when in the same room. This blurring of borders gives users an expectation of performance that is difficult to meet when the participants do not recognize the differences between face-to-face and distance learning. (Hsu and Bruce 1999). The first step in addressing the blurring borders is to recognize that distance learning is not the same as face-to-face, and then compensate for the differences as suggested in Section 5 of this paper.

As Alessi and Trollip (Alessi and Trollip 2001) argue, competitively comparing traditional and distance learning is not what should drive a learner or instructor toward or away from a new medium, instead, each mode of teaching and learning should be considered for its inherent benefits and detractors, and each mode should be used where it is most likely to succeed. Part of the process of accommodating the differences in face-to-face and distance learning is using the differences to an instructor's and student's advantage. In face-to-face instruction, most instructors do not allow multiple students to ask questions simultaneously when in a classroom, but this is exactly what happens via a chat interface. When the medium allows students to ask questions via chat without interrupting the class, the instructor must accommodate this additional

channel and understand its implications for the flow and structure of the class. Instead of forcing students to "wait their turn" to ask a question, the instructor should allow the students to submit questions at will, which may mean the instructor will require an assistant to track the students' spontaneous and simultaneous questions. This also requires students to understand the differences between face-to-face and distance learning, and to be comfortable with using the different tools that enable interaction in a distance medium.

Video, audio, chat, and other communications channels do increase student and instructor presence in a distance learning classroom, which is why they are implemented in this medium. It is therefore important to take advantage of the medium and use the various additional communications channels when appropriate. The interruption of a video stream during a distance learning session will of course disrupt the flow and content of the instruction, but when such a disruption is anticipated, the instructor and students can still participate in the class via redundant chat and audio interfaces. Both sides of the distance learning experience *must* be prepared to allow for and compensate for any technical problems. How to prepare for, adjust to, and take advantage of Distance Learning is covered in Section 5 and 6.1.

6.1 Designing for E-Learning

There are many sources of step-by-step instruction for implementing various systems and techniques in distance learning (see bibliography), but the sources rarely address the reasons for selecting one system or technique over another. While investigating and introducing distance learning technologies into the LTAP/TTAP curricula, I found that adapting the teaching and learning to best fit the environment and take advantage of the unique tools available helped make lessons successful and popular.

Alessi and Trollip address this tactic of adaptation to the learning environment and suggest four *phases of instruction* that consider the computer-assisted learning environment, which includes most distance learning. These phases are clearly taking advantage of the computer's ability to store, process, and transmit information. The phases are:

- Presenting information

- Guiding the Learner
- Practicing
- Assessing the Learner (Alessi and Trollip 2001)

The first step, presenting information, is an inherent strength of computers in the learning process. Modern computers and communications mediums emphasize ever richer multi-media presentation of information, and vendors are offering increasingly sophisticated means of leveraging the processing power of modern computers to deliver rich multi-media content. The systems evaluated for this project reflect the capabilities of current (2007) computers and networks, with each system offering a mix of synchronous voice, video, static image, and text transmission. As suggested by Alessi and Trollip, by adapting the information presentation to the medium, we avoided some of the technological pitfalls (e.g. limiting or avoiding video and IP-based audio transmission because of limited bandwidth and dividing day-long courses into 1-2 hour lessons over multiple days) and took advantage of capabilities not easily offered in face-to-face learning (e.g. spontaneous and simultaneous interaction by chat, instant polling, and role-played scenarios).

The second step, guiding the learner, is a careful balance between controlling the learner's progress and outcomes, and encouraging the learner to learn on her own. Educators can readily apply e-learning technology in a controlling function, which would require programming and application of user controls by the instructional designer. Using technology in less-controlled environments can increase the burden on student and instructor, since the user is expected to apply technology on her own, and the geographically removed instructor would have difficulty asserting control over the students' behavior, presence, or responses. The greatest challenge to instructors in an e-learning environment may be keeping students on-track toward an expected outcome, since the technology tends to give access to information and communication beyond the classroom and students may feel less compelled to communicate with instructors formally. In section 6.2 below, I discuss more of the tradeoffs and opportunities that e-learning brings to the learning environment.

Computers are well-suited to the practice and assessment phases for many lessons. Again, the e-educator must design the practice and assessment for the electronic medium, and some lessons are difficult or impossible to provide adequate practice and assessment. Much of the instruction that LTAP/TTAPs deliver involves hands-on application of tools and techniques that cannot be fully simulated using a computer, e.g. welding, tire maintenance, surveying, and chainsaw use. For these types of workshops, the computer is best used for the theory portions of the training and to assess the "book" skills that these courses also contain.

6.2 E-Learning Vs. Constructivism Vs. Behaviorism

In broad terms, constructivist pedagogical theory emphasizes learner-initiated education, whereby the student constructs a reality from information acquired in the learning process. The role of the constructivist instructor might be thought of as a guide or counselor to help the learner find the knowledge on her own, as opposed to a teacher who delivers the knowledge in a format that the student must adapt to.

E-learning poses both problems and potential for constructivists. The problems arise when e-learning is "taken advantage of" as a means to efficiently deliver information beyond the borders of a physical classroom. In this case, online learning is a method of delivering "instruction" efficiently and consistently across time and space. Many multi-media learning environments encourage a student to repeat processes until they are learned, or at least memorized. This mode of instruction falls much closer to behaviorist pedagogy, whereby the student is taught to repeat what the instructor (computer) is delivering via the screen, and evaluated using highly efficient computer-based quizzing tools. Even in live or highly interactive e-learning environments, the e-learning tools are often simply a means of delivering information to remote students with the expectation that the student will absorb the data with more efficiency for the instructor and teaching institution.

Behavioral learning is what most of us know from formal education: Learn the lesson, and receive an evaluation of that learning by scoring well on a standardized test. As a behaviorist's tool, computers and distance education can hardly be more ideal. E-learners can be taught and

evaluated en-masse using standardized instruction and evaluation, assuring uniform knowledge acquisition across broad segments of the population.

At the same time, the e-learning environment offers students a wide array of tools to explore on their own and construct knowledge based on their own investigations. Search engines, on-line databases, and spontaneous collaboration allow a student to learn at her own pace, using information resources far beyond the capacity of even the largest academic library. The problem for the e-learning instructor is often that a student is doing exactly what a constructivist would hope for: Leaving the lesson to spontaneously explore the Internet and discuss with her colleagues and instructors what she discovers.

In section 5.0, Teaching Techniques and Issues for On-line Learning, I look at many of the issues related to teaching on line. Many of these issues arise because of the format we chose, one where students were not managed or carefully coached in how to interact with the class and instructor. Choosing to let students participate however they like, and if they like, requires the students and teachers to understand and accept the risks involved in a constuctivist learning mode. Our trials led us to understand the risks and react to them, and in time, students also learned to work within the unstated bounds of a loosely-structured learning environment.

Both the behaviorist and the constructivist can therefore use e-learning as a powerful teaching tool, but the growth of the Internet and access to it is tipping the balance further in favor of the constructivist. Well-designed behaviorist e-teaching tools require extensive programming, information management, and student control; whereas the constructivist can merely suggest direction for the learner, and let the Internet provide the students with an environment for free exploration.

6.3 Pedagogy In Practice at LTAP/TTAP

In the training developed over the past two years in the LTAP and TTAP, we have attempted development of content firmly in the behaviorist's camp, with little success. Some of our first classes and learning modules contained "packaged" content from Federal and state agencies that

we adapted to the on-line environment. We spent many hours narrating lessons and building quizzes for students to download and evaluate themselves with, assembled hours of scripted computer animations for students to view on-line, and simulcast classroom lessons across the Internet.

Much of the software and systems available to instructional designers emphasize structured lessons, repeatability, ease of distribution, and controlled delivery. We used animation, HTML, on-line surveys, and web-based video to create our packaged lessons and made them available to anyone who wished to download them. We designed lessons to carefully monitor student outcomes and progress, seeking systems that would allow us to monitor individual students over extended periods of time. To us, this unconscious choice of teaching in a behaviorist mode was intuitive, as most of the designers and instructors in our group had extensive experience in the traditional classrooms of a technological university, where instruction followed by formal evaluation to verify knowledge transfer is widely practiced.

E-learning offers behaviorists excellent tools for developing, delivering, and managing lessons with automated evaluation and monitoring. Unfortunately (or perhaps, fortunately), the same resource constraints that limit a TTAP or LTAP from delivering traditional training to a broad constituency also restrict the development of the types of curricula that a behaviorist would like. The first problem we faced was the tremendous time resources required to assemble these instructional materials. A widely quoted statistic is that one hour of on-line learning requires 100 hours of preparation (New Training and Technology Transfer Methods in Distance Learning 2006), which we were able to verify through our own experience. The results of our attempt to create and monitor carefully controlled lessons have not been impressive. We have not had the resources to complete adequate numbers of lessons, nor the tools to adequately enroll, monitor, and evaluate students as they complete the lessons.

Without a conscious effort to abandon the behavioral methods of instruction, we began to offer students other methods of instruction that better fit our constrained resources and organically structured community of teachers and learners. These methods included demonstrations of proper technique in simulated environments, spontaneous discussion using the on-line discussion

tools, unstructured one-on-one guidance, and on-line performances of simulated scenarios. We arrived at these methods by simply trying new ways of presenting information and evaluating our success or failure based on student feedback.

We judge our training and meeting performance based on anecdotal and formal evaluation, audience participation, and attendance. Repeat attendance by individual students in subsequent workshops gives us a particularly good indication of whether students find our methods to be interesting and effective. This is especially true in the on-line environment, where students can easily forego attendance without excuse. In all cases where we adopted the less behaviorist methods above, student participation, response, and repeat attendance met or exceeded face-to-face meetings.

We developed short on-line live training programs designed to introduce our students to concepts, rather than provide an exhaustive lesson plan filled with detailed instruction. Instead of presenting a monolog of the steps required to collect data on sign, pavement, and guardrail inventory, we "performed" scenarios over the Internet to help students conceptualize the processes required to properly inventory their own road assets. The "performance" included sound effects and dialog between several "actors," and the e-learning interface gave us a means to project a simulated activity to our audience.

One example of a performance conducted at LTAP is the live demonstration of the steps required to input a sign into a client's inventory software. In one lesson, the instructor uses a loose script to guide him through a sign data collection procedure, which the students can observe on their own computers via an Internet connection. The instructor encourages students to spontaneously interact with each other and the teacher using the chat tools or synchronous audio connection. The students are viewing a demonstration based on real data in a sample jurisdiction, and are therefore required to adapt this demonstration to their own datasets and jurisdictions. During the lesson, the instructor can invite a student to try the process on their own on the instructor's computer, and the e-learning environment enables the instructor to observe the student as she performs a similar data collection task on her own computer.

Another very successful scenario-based instruction used is the "demonstration" of field data collection for remote students. This method proved even more effective than face-to-face demonstrations of the same process. In this method, the instructor "takes a ride in the data collection team van," demonstrating the steps needed to collect data while "on the road." Through the use of sound effects such as jingling keys, closing car doors, seat belt chimes, and road noise, the remote students imagine themselves in the field data collection environment, and better understand the application of the various tools they will need to perform data collection on the road. In face-to-face training, students had difficulty understanding when to use which tool for their data collection procedures because it was not possible to take the class out on the road, but the on-line performance of a "field data collection" helped them visualize where and when to use which tool. Many students admitted that they believed the instructor had left her office and driven the van around the city using a mobile phone and Internet connection. The demonstration of this method is best described by viewing the recording of this lesson.

In these successful distance-learning lessons, we helped the students successfully construct a reality within which they could imagine themselves performing the tasks we demonstrated. We did not evaluate their performance nor give them explicit instruction. The students spontaneously interacted with each other and the instructors, and because we were prepared to respond to multiple questions streaming in over the chat interface, we were not overwhelmed and students did not hesitate to ask questions or even take control of the instructor's workstation to try their newly gained knowledge.

In all of our successful distance-learning lessons, we have tailored our instruction to fit within the environment we have available, taking advantage of the medium while adapting to the problems that accompany it. This customization of our training methods meets the resource and technological constraints of the typical LTAP/TTAP, and corresponds with research showing that e-learning is most effective when the methods fit the medium.

Whether to choose constructivist, behaviorist, or any other learning theory is not what is being argued here, but rather, the instruction should adapt to the particular instructor's technical, organization, and theoretical boundaries. In the case of the less formal instruction environment of

an LTAP/TTAP, instructors should at least consider a constructivist approach to instruction and take advantage of the systems emerging in the modern e-learning environment to favor student spontaneity and self-direction.

7.0 Conclusion and Suggested Further Investigations

7.1 Suggested further investigation

Distance education tools are rapidly changing, and students and teachers are becoming increasingly proficient at using these tools. Distance education practices therefore require constant re-evaluation to improve the teaching and learning process. As the tools and knowledge of the field develop, current practices must be assessed so that students do not lose interest in the curricula because of outdated delivery methods.

The typical students in an LTAP or TTAP classroom differ from traditional university, primary, or secondary school students, so future investigations should focus on these differences and help guide the development of distance education tools and practices for this community. Investigating the ways adults learn using these tools, and looking at the ways students from diverse cultures and backgrounds might learn differently from each other would also contribute to improved teaching and learning in LTAP and TTAP programs.

7.2 A review of the approach, process, and results of this project

Even though distance education tools are quickly evolving and new technologies are appearing, the fundamentals that affect the learning process remain the same: Understand the lesson goals, be aware of the audience's needs and expectations, and adapt the delivery to compensate for the medium and audience's abilities. It is relatively simple to gather some materials and send them across the planet to a distant student. It is fairly difficult to be sure that the distant student is learning.

In practice, we found that our students received content and curricula best when the instructors focused on the outcome and modified the teaching process to reach that outcome. The loosely-organized, organic groups that make up the LTAP/TTAP classrooms reacted best to a less-structured outcome-based teaching process. We did attempt to create a carefully-controlled teaching process with detailed evaluations and content, but the speed at which the content changed and limited developer resources made this highly-managed content difficult to keep up-to-date, rendering the lessons unattractive or irrelevant. Those students who have access to a web-based learning environment tend to also have access to additional learning resources. By

helping students understand the goals of a lesson and giving them multiple approaches to reaching that goal became the most successful method of teaching LTAP/TTAP students.

The goals of this project were:

1. Find technologies and practices that will allow an LTAP or TTAP to teach remote students relevant curricula,

2. Ensure students obtain specific knowledge and skills using distance-education tools, and

3. Transfer knowledge gained about distance-education tools and practices so that novice instructors will succeed in using distance education tools in their curricula.

To achieve these goals, I evaluated technologies and practices that fit within the resource and organizational constraints of a typical LTAP and TTAP and determined the strengths and weaknesses of different technologies and practices. I then tested the evaluated tools and practices in actual classes to verify my assumptions. I used the results of each test to guide further development, and documented successes, failures, and key decisions.

The majority of time spent developing this project involved evaluating the instructional tools and processes that allowed the Michigan LTAP and Michigan Tech TTAP to deliver relevant lessons. Through trial-and-error, I learned that a goal-based constructivist teaching model works best with our students and instructors: LTAP and TTAP students, when given the resources and guidance needed to acquire knowledge on their own, will seek learning opportunities that develop their skills and improve their job performance.

Confirmation of the success of this project is provided by the invitations to present on the project's results at several national conferences. More importantly, the Michigan LTAP and Michigan Tech TTAP are using distance education technologies and practices investigated in this project, students and instructors are reacting positively to the distance-based curricula, and more students have more opportunities to learn from high quality instructors and curricula.

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9.0 Appendix A, Web-based Learning Tool Evaluations

The individual products evaluated for this project are listed below. The current versions of these products were tested on typical networks and computers available at a research university during 2006 and 2007. Some networks and computers were selected that fell outside the recommended standard configurations to evaluate performance in less-than-ideal situations. The testing environment was not controlled, but each product was tested over the course of at least six months to achieve a representative performance sample under varying conditions.

9.1 Product 1: Marratech Web-based Conferencing

As a starting point, *Marratech* provided an easy entry for TTAP into the web-based training field. Michigan Technological University uses *Marratech* extensively and there are several experienced technical support staff that were available to help with installation, configuration and management. MTU hosts classes on vulcanology and other topics with students throughout North America, Europe, Asia, and South America joining classes via the *Marratech* interface.

The basic design and functionality of *Marratech* is similar to most other web-based conferencing products: The instructor and students "meet" each other in a "room" via video and/or voice and text chat. Participants can use inexpensive video "Web cams" connected to their computers to send video of themselves and their surroundings (see Figure 9-1: *Marratech* Interface).

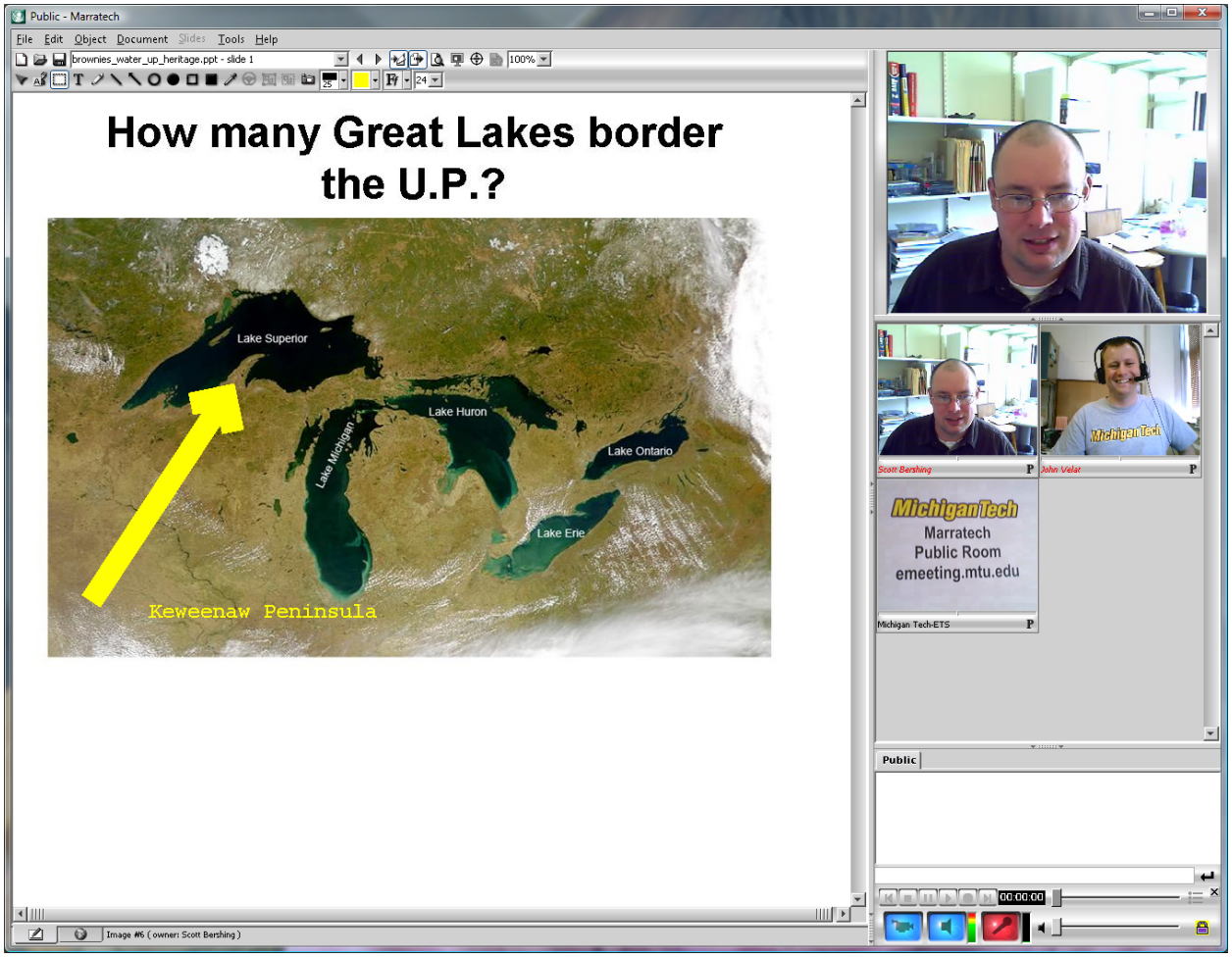

Figure 9-1: *Marratech* Interface

The *Marratech* Interface also provides a "whiteboard" area where students and instructors can draw, write, and share pictures for all to see. User and connection control is performed by system administrators on a central server. If users are authorized to access an open "room," they can "meet" spontaneously without notifying system administrators. Alternatively, users might request a private room that requires specific credentials or authorization to view the private room meeting. The system also allows users to record meetings for playback at a later time, which is useful for reviewing meeting content or to deliver the meeting content to those who could not attend the live meeting. An instructor could use the recording function to create on-demand asynchronous data in a "TV Show" format for students to view on their own. In the on-demand

recording format, students can pause, rewind, and fast forward through the recording. Table 9-1: How *Marratech* Met Web-Based Learning Tool Criteria shows how this software fared in the evaluation process.

Table 9-1: How *Marratech* Met Web-Based Learning Tool Criteria

1. Low cost	+The system is free to use for TTAP and its clients. -The system costs approximately $25,000 for 50 users.
2. Ease of student-side installation	+A free client download is available. -The client is 35MB and requires software installation privileges on the client's and instructor's computer.
3. Richness of media interface	+All participants share an equally-rich interface. +Multiple video streams can be shown +Video and audio quality is excellent when participants can access eachother and the server via very high-speed network connections -Video streams require a large amount of upload and download bandwidth. The system failed during our first experiment in the field, probably due to excessive bandwidth requirements
4. Availability to instructors and clients (lack of license restrictions)	+A free client download is available. -Server product is licensed and expensive
5. Ability to function across and through "secured" networks	+installed client functioned through and across firewalled networks. -client requires administrator privileges to install
6. Student and teacher manageability	+Teach can manage students -There is no integrated learning management system to monitor students' participation
7. Technical expertise needed to implement	+client is easy to install -client requires administrator privileges to install
8. Technical expertise available to assist	+MTU uses and can support -extensive support and training required if no local experts are available. -some problems could not be resolved by MTU support staff
9. Desirable features	

a. Sessions can be recorded for later playback	+Yes, as AVIs with audio
b. Audio integrated	+Yes, VOIP
c. Video integrated	+Yes, multiple streams
d. Polling/surveying/quizzing integrated	-none
e. LMS integration possible	-No direct integration, but can be used via links in an LMS
Subjective evaluation and comments	• *Marratech* functioned nearly flawlessly during on-campus trials and MTU frequently uses this software to teach remote students. • Our own field tests were complete failures. • Some users had difficulty configuring their computers, but these problems were associated with local configurations and apparently not with the software. • The interface is difficult to understand for novice and even experienced users. For example, buttons on the toolbar are not listed in the menus, and not explained with pop-up hints or messages during use. During testing, users frequently activated a feature only to not be able to figure out how to deactivate it. • *Marratech* audio and video quality can be outstanding. For meetings that require a very strong "presence" by the participants, participants who are connected via excellent very-high-speed network connections and have powerful computers, *Marratech* delivers a good meeting experience. • Trials on some newer versions of the Windows operating showed problems with compatibility. This is probably a transient problem that will be addressed in a near-future product release.

9.1.1 Evaluation and Conclusion

Marratech failed during its first trial in the field. The system regularly froze or communication became unintelligible soon after connecting one remote location with a "remote" user located in TTAP's offices. *Marratech* in it's current form should not be used as a tool for communicating with remote locations that do not have very high speed (>1Mb/s) and low latency network connections. In environments such as those where MTU uses *Marratech*, e.g. between workstations located at universities, *Marratech* provides a very rich experience. This product has several desirable functional advantages over other products, such as the ability to record sessions on any user's workstation and the ability to show a main speaker in a large video frame with

participants shown in thumbnail video frames. These functions increase bandwidth requirements and may be the reason why *Marratech* did not function well at a typical remote host location.

Along with the objective evaluations of features, the ability to connect, and software configuration, I evaluated the software on more subjective terms such as usability, ease of use, and design. In my opinion, *Marratech* did not present a well-implemented complete system for hosting a meeting. Uploading presentations was time consuming, and the resulting presentation was merely a "picture" of each slide. Because the results of a *PowerPoint* conversion and uploading could be seen only after several minutes, instructors using *Marratech* should upload their presentations one day or more before their class. For most educators, this would not be an issue, since they are not pressed for time and can spend many hours playing with technology. For a minority of educators, these technological glitches that prevent last-minute preparation are frustrating.

Because the system failed to provide elementary connectivity and reliability, I was not able to make further evaluations of training effectiveness or learner/instructor impressions, but this is a very powerful product that, when in the right environment, provides an excellent media experience.

9.2 Product 2: Adobe Acrobat Connect (formerly Macromedia Breeze and Adobe Breeze)

After the failure with *Marratech*, I decided to investigate other products that promised similar features. Several on-line reviews recommended Adobe *Acrobat Connect* (formerly Macromedia *Breeze* and Adobe *Breeze*). The Interface and collaboration tools of *Acrobat Connect* are similar to those in *Marratech* and other Web conferencing tools. Figure 9-2: Adobe *Acrobat Connect* Interface shows this software with a presentation and several remote users logged in. The example in Figure 9-2: Adobe *Acrobat Connect* Interface shows this product's flexibility in a particularly difficult presentation environment: One presenter is located on MTU's campus, a second presenter is at his home in Brasilia, Brazil, and several other participants joined the conference from government and university offices in Sao Paolo, Brazil and Brasilia. The hosting server is located somewhere in the USA. In this conference, we successfully

communicated using video and voice without a telephone connection. The chat functionality was a valuable asset for communicating when the voice quality degraded, and for reaching across language barriers. The Brazilian colleagues have continued to use this interface since this introduction, and have participated in collaborative training sessions with Federal Highway Administration (FHWA) instructors in the USA as well as held high-level meetings between Ministry of Transport and FHWA officials.

Figure 9-2: Adobe *Acrobat Connect* Interface

The differences between *Marratech* and *Acrobat Connect* are not immediately identifiable by looking at the common features of a video window, chat window, presentation area, and whiteboard. *Acrobat Connect* and other Web conferencing tools include additional features such as polling/survey/quiz tools, integration with LMS, and tools to enhance *PowerPoint* presentations. Polling tools allow participants to create questions and collect answers within the conferencing interface. This adds the possibility of immediate query and feedback, giving

teachers and students an additional means of interaction similar to the "everyone raise your hand who thinks Answer A is correct" query that one might use in a live classroom. In some ways, this method of query may encourage greater participation than the hand-raising classroom exercise, since the poll participants can "raise their hands" anonymously.

The integrated polling and quizzing features make integration with a Learning Management System important. Using either Adobe's LMS or another vendor, such as WebCT, allows the presenter to manage students, course content, and polling questions and answers. With LMS integration, an instructor can use the polling feature to quiz students and collect the results for student evaluation. Additionally, the *Acrobat Connect* product offers a tool called Adobe *Acrobat Connect Presenter* that integrates poll questions into *PowerPoint* presentations, the results of which can also be collected in the Learning Management System.

The LMS integration differentiates Adobe *Acrobat Connect* from the other products reviewed, making it more useful for a teaching/learning environment. While other products offer the capacity to meet with students, *Acrobat Connect* enables teachers to create, manage, and conduct an entire class, from content preparation through enrollment, presentation, and evaluation. There are many ways to manage courses and students and evaluate learning goals, but the integration of these features into a complete e-learning system becomes increasingly important as you progress past the use of Web-based tools for ad-hoc meetings.

Adobe *Acrobat Connect*'s *PowerPoint* module allows an instructor to prepare a complete lesson in *PowerPoint* for on-demand or interactive use, and adds functionality such as polling, quizzes, evaluation, narration, timing, and learning progress management. This tool enables an instructor to prepare a complete module with content for self-directed learning, which expands the scope of web-based learning beyond live meetings. The resulting module can also be more accessible than live meetings, with integrated text narration in addition to the audio track. I will describe the Adobe *Acrobat Connect Presenter* tool in greater detail later in this paper.

9.2.1 Evaluation and Conclusion

After several in-office trials using a similar configuration to

Figure 4-1: Schematic of a Remote Classroom Test with MTU-Based Web Conferencing Server, but with the server located off-campus, Dr. Alkire and I decided to perform an in-field trial with Adobe *Acrobat Connect*. The field trial was configured as in **Error! Reference source not found.**. The major difference between the *Marratech* and Adobe *Acrobat Connect* configurations is in the server location. The Adobe *Acrobat Connect* server in this trial is located off campus at a commercial server center. If MTU had licensed Adobe *Acrobat Connect* and located the server on campus, the configuration would be the same as in *Figure 4-1: Schematic of a Remote Classroom Test with MTU-Based Web Conferencing Server*. The remote workstation and TTAP-based workstation were set up using the devices as in *Figure 4-2: Schematic of Devices Required or Optional for Web Conferencing*, but without a dedicated phone connection for the voice communication.

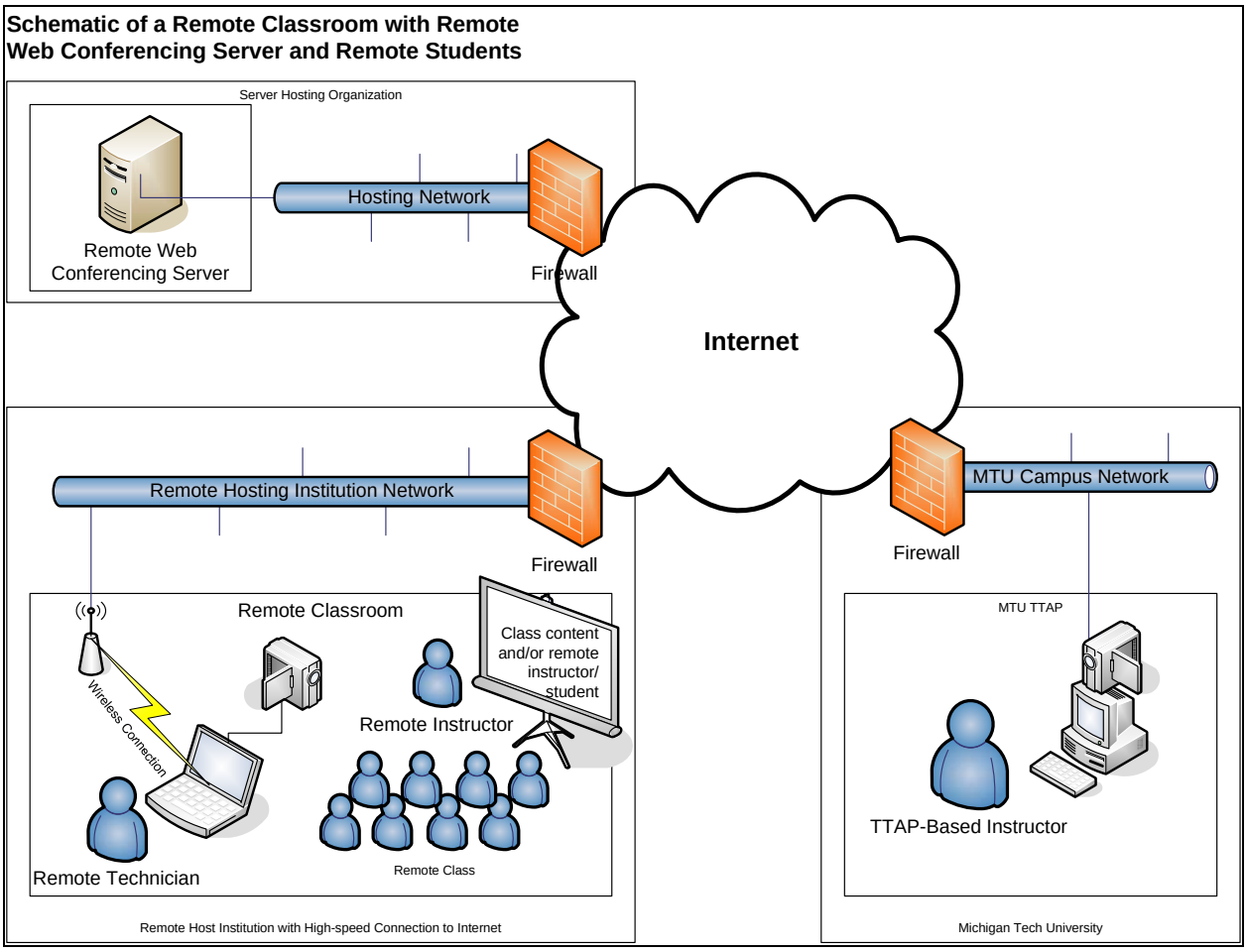

Figure 9-3: Schematic of a Remote Classroom with Remote Web Conferencing Server and Remote Students using Adobe *Acrobat Connect* (*Breeze*)

For the first field trial, I attended the remote class, simulating a student connecting to the class from a remote location, but sitting in the same room as the class. The instructor's computer served as both the presenter's workstation for the class and the broadcast station that serves the class material to remote students. This trial took place at a rural Midwest tribe in a typical tribal conference facility. The facility advertised a 3mbps Internet connection and wireless access within the conference rooms, which is similar to most tribal conference facilities and should be adequate for using the software.

The first Adobe *Acrobat Connect* field trial showed that two-way voice and video communication was possible in the test environment and course content was successfully

transmitted from the instructor to the "student." The on-campus and off-campus trials were adequate to prove the concept of delivering training to remote users. Table 9-2: How Adobe *Acrobat Connect* Met Web-Based Learning Tool Criteria shows how this software fared in the evaluation process.

Table 9-2: How Adobe *Acrobat Connect* Met Web-Based Learning Tool Criteria

1. Low cost	+The system is free to use for TTAP and its clients. -The system costs approximately $25,000 for 50 users.
2. Ease of student-side installation	+A free client loads automatically upon connection with a meeting room. +The client loads quickly on every computer tested and even when the current user is restricted by system administrators
3. Richness of media interface	+All participants share an equally-rich interface. +Multiple video streams can be shown +Supports many file formats natively, and many more with conversion to Adobe Flash.
4. Availability to instructors and clients (lack of license restrictions)	+A free client download is available. -Server product is licensed and expensive
5. Ability to function across and through "secured" networks	+installed client functioned through and across firewalled networks.
6. Student and teacher manageability	+Teacher can manage students +A complete LMS is available to manage events, students, content, survey/quiz results, etc.
7. Technical expertise needed to implement	+client installs automatically in all tested platforms and browsers
8. Technical expertise available to assist	-No local support at MTU +TTAP has limited no-cost access to FHWA support staff
9. Desirable features	
a. Sessions can be recorded for later playback	+Yes, with and without audio -Recorded sessions cannot be downloaded to local computers (as with any software, a local computer can be used to record voice and data into a local copy, but this is not a built-in feature)

b. Audio integrated	+Yes, VOIP
c. Video integrated	+Yes, multiple streams
d. Polling/surveying/quizzing integrated	+Yes, on the fly +Yes, pre-entered +Extensive polling, surveying, and quizzing functionality, including automatic assessment and pass/fail progress limiter
e. LMS integration possible	+LMS included in full package +/-According to documentation, Adobe *Acrobat Connect* content and output can be integrated into WebCT and other LMS, but I could not accomplish this (possible support issue that could be solved if I were a "paying customer")
Subjective reliability and usability assessment	• Adobe *Acrobat Connect* functioned nearly flawlessly during all trials and field tests. Some users had difficulty configuring their computers, but these problems were associated with local configurations and apparently not with the software. • The placement and configuration of the video frames is limited, and the video compression is very aggressive. This does provide for more tolerance of slower network connections, but it would be nice if the software could be configured to provide a higher-quality video and voice connection when participants had higher-speed network and workstations. • The interface is intuitive and simple. Most users, novices and experts alike, quickly learned to use the programs basic and some advanced features. • Adobe *Acrobat Connect*'s software design takes advantage of the ubiquitous Adobe technologies such as Flash, which probably contributes to this product's ability to function on nearly any platform and with low sensitivity to local workstation configuration.

For the next step in testing, Dr. Alkire again agreed to serve as the "technician" at a remote training. For this training, I would remain at the TTAP offices to work as a moderator. In addition, I set up a second workstation running as a "student" in the TTAP offices to evaluate the remote training as a student would likely experience it. For this trial, Dr. Alkire connected two workstations at the remote conference facility, one for him and one hosting the instructor's presentation materials while simultaneously transmitting course content and an image of the instructor to the remote audience.

This second Adobe *Acrobat Connect* field test was also successful at transmitting the course information to remote users and we decided to move on to more testing, but invite real students to participate in the training while evaluating this new instruction method. Later in this paper, I will describe the lessons learned from these tests, and how I addressed issues of voice and video fidelity, content delivery, and remote participation.

9.3 Product 3, NetSpoke

We used *NetSpoke* for several on-line workshops to teach users how to use custom software published by Michigan Tech. *NetSpoke* shares many of the features of *Marratech*, *Acrobat Connect*, and other Web-conferencing tools, including a "white board", presentation sharing area, chat window, participant list, and application sharing. *NetSpoke* does not have built-in audio and video, but it is integrated with the publisher's telephone-based audio conferencing system. Although you cannot use *NetSpoke* to make voice calls, your telephone number is shown in the participant list when you call to join the conference, and some call control commands can be made from the *NetSpoke* interface, and some Web conferencing commands can be made via the telephone.

Table 9-3: How *NetSpoke* Met Web-Based Learning Tool Criteria

1. Low cost	+The system costs $0.18 per minute per user with no minimums or additional services costs.
2. Ease of student-side installation	+A free client loads automatically upon connection with a meeting room. +The client loads quickly on every computer tested and even when the current user is restricted by system administrators -The installation process involves testing the user's computer, and the test results often erroneously tell the user that they cannot run the software.
3. Richness of media interface	- The interface lacks video and audio
4. Availability to instructors and clients (lack of license restrictions)	+A free client download is available. - There is no option to "own" the software, it is supplied only through a remote service

5. Ability to function across and through "secured" networks	+installed client functioned through and across firewalled networks.
6. Student and teacher manageability	+Teacher can manage students using the software interface.
7. Technical expertise needed to implement	- Students and instructors faced erratic installation and use problems, even after extensive testing and troubleshooting
8. Technical expertise available to assist	-No local support at MTU - Remote support was unable to solve most of the problems addressed to them
9. Desirable features	
a. Sessions can be recorded for later playback	+Yes, with and without audio -Recording seems to affect the recording computer's performance. Recording should be done on a dedicated computer that is not presenting
b. Audio integrated	- No. +Telephone-based conference integrates with the computer-based interface.
c. Video integrated	- No.
d. Polling/surveying/quizzing integrated	+Yes, on the fly +Yes, pre-entered
e. LMS integration possible	- No.
Subjective reliability and usability assessment	• This software functioned well when fewer than five users/presenters were connected simultaneously. Erratic performance and reliability increased as the number of users increased.

9.3.1 Evaluation and Conclusion

NetSpoke's performance was too erratic to use as a reliable learning platform. Although the performance and features were promising when tested with 2-5 users, the software failed during every live training when more than five users logged on.

9.4 Product 4, Adobe Acrobat Connect Presenter PowerPoint Plug-in

Part of the Adobe *Acrobat Connect* package is the Presenter Plug-in for Microsoft *PowerPoint*. I have evaluated this as a separate product because the resulting content can be delivered without access to the rest of the Adobe Acrobat Connect system, although the product is not available without purchasing other parts of the Adobe system. Similar products are available from other vendors.

This software offers presenters additional tools for making *PowerPoint* presentations interactive and for packaging a *PowerPoint* presentation for on-demand viewing. Using this tool, a presenter can also narrate a *PowerPoint* presentation and structure it to include automatic evaluation of user responses and viewing.

Presentations enhanced with the *Presenter* plug-in can be uploaded to the live learning environment, or presented as standalone modules. When integrated with a Learning Management System (LMS), on-demand presentations with quizzes and surveys can pass user responses and viewing times to the LMS for automatic or teacher evaluation. The LMS can use the evaluation data to allow or deny progress and access to succeeding modules.

An example of a *Presenter*-enhanced *PowerPoint* presentation can be viewed and at http://fhwa.acrobat.com/mittaprsa1/. This on-demand module is hosted on the FHWA server and will be part of the TTAP on-line curriculum.