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Abstract

Immersive telepresence systems offer a new standard of high definition video, high-resolution audio, life-size displays, and camera and microphone arrays that together create a new level of seamless video conferencing experiences. The result is a communication and learning environment that virtually recreates the immediacy of face-to-face group conversations. However, few quantitative research studies have been conducted to test the return on investment compared to the impact on students. This presentation and article present the early findings of an experimental study that investigated learning effectiveness and student perceptions of instructor credibility and immediacy. These results were compared to other online multimedia treatment groups, using the same content, instructor, and presentation slides. Analysis of Variance and post hoc comparisons indicated several statistically significant differences between the Immersive TelePresence treatment group and the other presentation trials. The findings strongly suggest technology and instructional systems design best practices based on student preferences for multimedia environments. For instance, learners in the TelePresence treatment group were less likely to drop the course, felt they learned more, felt they did not have to work as hard to learn, and found the instructor more credible.

Keywords: multimedia learning, telepresence, credibility, immediacy

Immersive Telepresence and Student Perceptions of Instructor Credibility and Immediacy

Video conferencing is an effective communication technique that can be used to decrease transactional distance and increase engagement and interaction in learning environments (Moore, 1993). Two-way audio and video conferencing in real time allow for a learning environment where distance students cannot only learn from the instructor but they can also learn from each other. While in theory evolving video conferencing technologies could replicate face-to-face learning, in practice implementation in the 1990s and early 2000s still lacked the overall quality required for seamless interaction and discussion (Knipe & Lee, 2002). The technology continued to evolve and improve. However, further research into empirical learning effectiveness and outcomes were still missing (Lawson, Comber, Gage, & Cullum-Hanshaw, 2010). Today the state of the technology was developed to the point where Immersive TelePresence systems such as the Cisco IX5000 and IX5200 are the current closest, practical means to replicate face-to-face learning experiences.

The Cisco IX5000 and the dual row IX5200, each utilizes Cisco's experience in high definition video conferencing, and each applies the latest in audio and video technology. For instance, the three screens display in 1080p resolution, the three-camera array captures in 4K resolution (2160p, 60 fps), with 54 auto gain controlled microphones, 12 mid-range speakers, six tweeters, and a high-fidelity subwoofer (Cisco, 2015). The intent of Cisco's Immersive TelePresence is to 'immerse' the participant into a communication environment that more than ever before replicates the eye-to-eye experience with life-like, life-size video and very high

fidelity, directional audio. Participants in a TelePresence meeting feel like they are all in the same room together, despite the actual distances between them. However, what empirical evidence is there that supports the return on investment of this impressive implementation of state-of-the-art technology?

Enhancing student motivation is a critical aspect of instructional design, especially for online environments where students very often have a sense of isolation. Aspects of student motivational, such as fostering instructor credibility and immediacy, should enhance learning and retention in multimedia enhanced learning environments. Previous research has investigated the impact of message and multimedia design in terms of credibility and immediacy in an effort to create and inform evidence-based instructional design best practices (Jayasinghe, Morrison, & Ross, 1997; Morrison, Watson, & Ramlatchan, 2013). A specific recent research study built upon this precedence and included five variances of a single multimedia presentation that modified the layout and inclusion of instructor video and the instructor's visual content (Ramlatchan, 2016a). However, there is little to no empirical, quantitative research on the effectiveness of Immersive TelePresence in multimedia learning or instructional systems design contexts. The purpose of this experiment was to fill this gap by extending the previous 2016 multimedia research study by adding a new sixth treatment group that viewed the same instructional content now in an Immersive TelePresence classroom.

Theoretical Foundations

Telepresence

Two-way audio and video conferencing are an effective communication technique, especially in the context of distance learning and education. However, recent technology

improvements have allowed for an immersive experience that more closely than ever before replicates the face-to-face learning environment. There are three specifications that define telepresence (Schloerb, 1995). There must be a set of tasks, such as learning objectives, there should be an impact on a participant's senses, such as sight and sound stimuli, and the system should induce a transformation of presence, such as creating a perception of being somewhere else. Also, a telepresence experience includes both the virtual and the physical environment (Taeyong & Biocca, 1997). Effective immersion requires not only attention to the technology used for communication but also includes attention to the physical environment, such as room design. Previous Cisco TelePresence implementations required strict adherence to room design requirements such as HVAC, power, and wall paint color. While the IX5000 series requirements are not as strict, attention to room design is still relevant. The room used for the IX5200 system in this study benefited from new paint, carpet, attractive executive style conference room chairs, a wireless access point for class and meeting participants, and new data drops and power for the system. Another research study implemented immersive telepresence in the form of the combined physical and virtual environment of a flight simulator (Nicovich, Boller, & Cornwell, 2005). During this study, the researchers concluded that the design of an authentic environment should consider both the cognitive and emotional aspects of the design. Attention to the 'feel' of the system will enhance the immersive experience and the sense of 'being there' is created by both the technology and the physical environment.

Multimedia Learning Theory

Multimedia learning theory defines a set of evidence-based heuristics that can be applied by instructors and instructional designers to improve learning (Mayer, 2014). Multimedia learning theory builds on Baddeley's concept of working memory limits in the context of

learning, Paivio's principle of dual coding, and Sweller's cognitive load theory (Baddeley, 1992; Paivio, 1991; & Sweller, 1991). These foundational principles in educational psychology and instruction design state that learners have limited working memory resources that are available to process new information and create long-term schemata, or patterns of information. These new schemata are stored in long-term memory as new learning. Mayer's multimedia learning theory builds on this foundation and states that learners have two cognitive processing channels for processing information stored in working memory. One channel is used to process visual information while another channel is used to process auditory information; learning is more efficient when designers and instructors simultaneously engage both processing channels. Learning with audio and video is more effective than learning from visual content alone or from narrative content alone.

Credibility and Immediacy

Message design and instructional learning environments can impact student motivation for learning in terms of perceptions of instructor credibility and immediacy (Jayasinghe et al., 1997). Students will be more motivated to learn if they feel their instructor is credible; this credibility is comprised of three constructs: competence, goodwill, and trustworthiness (McCroskey & Teven, 1999). An instructor's competence is the learner's perception of the instructor as a subject matter expert. Goodwill is the learner's perception that the instructor is genuinely willing to help students learn the content. Trustworthiness is the student's perception that the instructor honestly cares about the learning of the students. Meanwhile, immediacy is the communication and teaching effectiveness of the instructor (Richmond, Gorham, & McCroskey, 1987). Verbal aspects of communication are important, but so are the nonverbal gestures, tones, smiles, eye-contact and other visual cues humans use when communicating

(Mehrabian, 1968). Aspects of immediacy become especially important for online and distance learning students, where enhanced immediacy can reduce psychological distance.

The present research study applies and expands upon the use of telepresence technology, applications of multimedia learning theory, and the motivational aspects of enhancing credibility and immediacy through instructional design. Specifically, the purpose of this experiment was to compare the effects of Instructor Only, Slides Only, Video Switching, Dual Windows, Superimposed Slides, and Immersive TelePresence multimedia presentation designs on cognitive load, learning effectiveness, perceived instructor credibility, immediacy, and instructional environment design.

Research Questions

This empirical research study included the data collected in Ramlatchan 2016a and collected new data to address the following research questions among undergraduate and graduate students enrolled at a mid-sized, public, metropolitan university.

1. How do the use of Instructor Only, Slides Only, Video Switching, Dual Windows, Superimposed Slides, and Immersive TelePresence multimedia presentation designs compare in terms of learner perception of instructor credibility?
2. How do the use of Instructor Only, Slides Only, Video Switching, Dual Windows, Superimposed Slides, and Immersive TelePresence multimedia presentation designs compare in terms of learner perception of instructor nonverbal immediacy?
3. How do the use of Instructor Only, Slides Only, Video Switching, Dual Windows, Superimposed Slides, and Immersive TelePresence multimedia presentation designs compare in terms of learner perceptions of learning environment design?

4. How do the use of Instructor Only, Slides Only, Video Switching, Dual Windows, Superimposed Slides, and Immersive TelePresence multimedia presentation designs compare in terms of learner perceptions of cognitive load?

Research Methods

Multimedia Design.

The original five-treatment group multimedia study included an Instructor Only, Slides Only, Video Switching, Dual Windows, and a Superimposed Slides version (Ramlatchan, 2016a). Students in these five trials were allowed to use any Internet enabled device of their choice to view their assigned presentation. The present study added a sixth treatment group using the same pre-recorded instructor on a Cisco IX5200 Immersive TelePresence system. Each treatment group included identical audio narration.

Students assigned to the Instructor Only group saw the video of the instructor for the duration of the 20-minute video module (see Figure 1a). Students assigned to the Slides Only treatment groups saw only the instructor's slides for the 20-minute video module (see Figure 1b). Randomly assigned participants in the Video Switching group first saw video of their instructor; the video would then switch to a view of the presentation slides as the instructor was specifically talking about the content of the slides. The video would then switch back to the instructor, then back to show the next slide, then back to the instructor. In this group, students could see both the instructor and the slides though not at the same time (see Figure 1c). Students in the Dual Windows group saw a larger window of the slides and the instructor in a smaller window, both visible on the screen at the same time. This layout is the recording default used by the host university's Cisco Telepresence Content Server used to archive and distribute online class

Figure 1a. Participants in the Instructor Only treatment group only saw video of the instructor during the 20-minute presentation. These students did not see the slides. Narration audio was the same in each treatment.

Figure 1b. Participants in the Slides Only treatment group only saw the instructor's slides during the 20-minute presentation. These students did not see the instructor.

Figure 1c. Participants in the Video Switching treatment group saw the instructor then the video switched to the slides, then back to the instructor, then back to the slides during the 20-minute presentation. Students could see both the instructor and the slides, though not at the same time.

Figure 1d. Participants in the Dual Windows treatment group saw the slides in their screen's larger window and saw the instructor in a smaller window. Students could see both the instructor and the slides at the same time in this arrangement.

Figure 1e. Participants in the Superimposed Slides treatment group saw the slides superimposed behind the video of the instructor. Students could also see both the instructor and the slides at the same time in this arrangement.

Figure 1f. Participants in the Immersive TelePresence treatment group saw the slides in the Cisco IX5200's outer displays and the instructor in the middle display. Students could also see both the instructor and the slides at the same time in this arrangement.

Figure 1. Each of the six treatment groups used a different multimedia configuration to help determine which design would be the most effective.

meetings, and allows students to always see both the instructor and the slides at the same time (see Figure 1d). Participants in the Superimposed Slides group viewed a version of the presentation that was a post production composite of three video layers. The first layer was the virtual background, a simple black background was used in this study, the second layer was the slides, and the foreground layer was the instructor video. The host university uses this layout in video modules used for asynchronous online classes. In this view, the students could also always see both the instructor and the slides with the slides superimposed just over and behind the instructor's left shoulder as she appeared in the video (see Figure 1e). The newest treatment group added by the present study included a Cisco IX5200 with the instructor video in high definition on the center 70-inch screen, and the presentation slides on the two outer 70-inch screens. This arrangement is very similar to how the Cisco IX5200 is used by the host university during graduate and undergraduate distance learning classes (see Figure 1f).

Survey Instruments

The survey instruments used in this study have been used in previous multimedia studies and have a track record of good internal validity and reliability (Jayasinghe, 1995; Jayasinghe et al., 1997; Morrison et al., 2013; Ramlatchan, 2016a). Perceived instructor credibility was measured with McCrosky's Source Credibility Measure which includes three constructs for competence, goodwill, and trustworthiness (McCroskey & Teven, 1999). Perceived instructor immediacy was measured primarily with the Nonverbal Immediacy Behaviors Index which gauges a viewer's perception of a presenter's gestures, vocal tone, smile, eye-contact, and posture (Richmond, Gorham, & McCroskey, 1987). The overall design of the learning environment was measured with Morrison's Instructor Evaluation Measure which included items related to motivation and extraneous cognitive load as a result of instructional design

(Jayasinghe, 1995; Jayasinghe et al., 1997). Cognitive load was measured with the US National Aeronautics and Space Administration's (NASA) Task Load Index (TLX), this instrument was developed in the mid-1980s to measure distractions and interface design effectiveness of aircraft instrument panels (Hart & Staveland, 1988). The NASA TLX has since been used in a number of diverse studies to gauge message and instructional design effectiveness (Hart, 2008; Morrison, 2013; Reid, 2013).

Materials

A 20-minute presentation on the history of social media and social networking was used as the instructional content during this experiment. This content was also successfully used in previous studies to measure student perceptions of credibility and immediacy (Morrison et al., 2013; Ramlatchan, 2016a; 2016b). An experienced female instructor was recorded in a professional video production studio and the multimedia presentation in each individual treatment group is a derivative of this single record session. As such, while the presented designs varied, all students viewed the same instructor, with the same narration, presenting the same content, and the same subject matter.

Participants

The host university's online and on-campus student population provided the sample of participants used in the study. Two hundred and seventy-six student volunteers were randomly assigned into groups and completed the first survey; 245 students continued on to complete the entire study. The sample represented a gender split of 58.7% female and 37.3% male, with an average age of 26.5, a median age of 23, and an age range from 17 to 66. The result was 39 students in the Instructor Only, 48 students in the Slides Only, 43 students in the Video

Switching, 40 students in the Superimposed Slides, 38 students in the Dual Windows treatment groups and 34 students in the new Immersive TelePresence treatment group.

Participant Procedures

The participant procedures in the present study were identical to the procedures in the previous multimedia study (Ramlatchan, 2016a). A posting soliciting for research participants was included in the university's daily Student Announcement email. This electronic newsletter is sent every morning to all university students (on-campus and online) and offered free t-shirts for research participants. Volunteers first read a description of the study then visited the link given in the research announcement. Students next read and agreed to the study's informed consent statement and then answered a short demographics questionnaire and pre-test. Research participants were then assigned into one of several ongoing treatments groups, one of which was the TelePresence trial in the present study. Participants assigned to the TelePresence group scheduled a convenient time to visit the classroom equipped with the Cisco IX5200 system and viewed the 20-minute presentation.

Results

A 6x1 Analysis of Variance was conducted on the data collected by each survey instrument; a follow-up Tukey post-hoc analysis was conducted to identify specific areas of statistically significant differences among the data. In terms of perceived instructor credibility, the inclusion of slides appeared to enhance the credibility of the instructor, $F(5,241) = 2.59$, $p < .05$. A distinct pattern emerged from a credibility low of Instructor Only (an average rating of $M = 4.99$, out of 7), to the highest rating of $M = 5.71$ by the TelePresence treatment group. The statistically

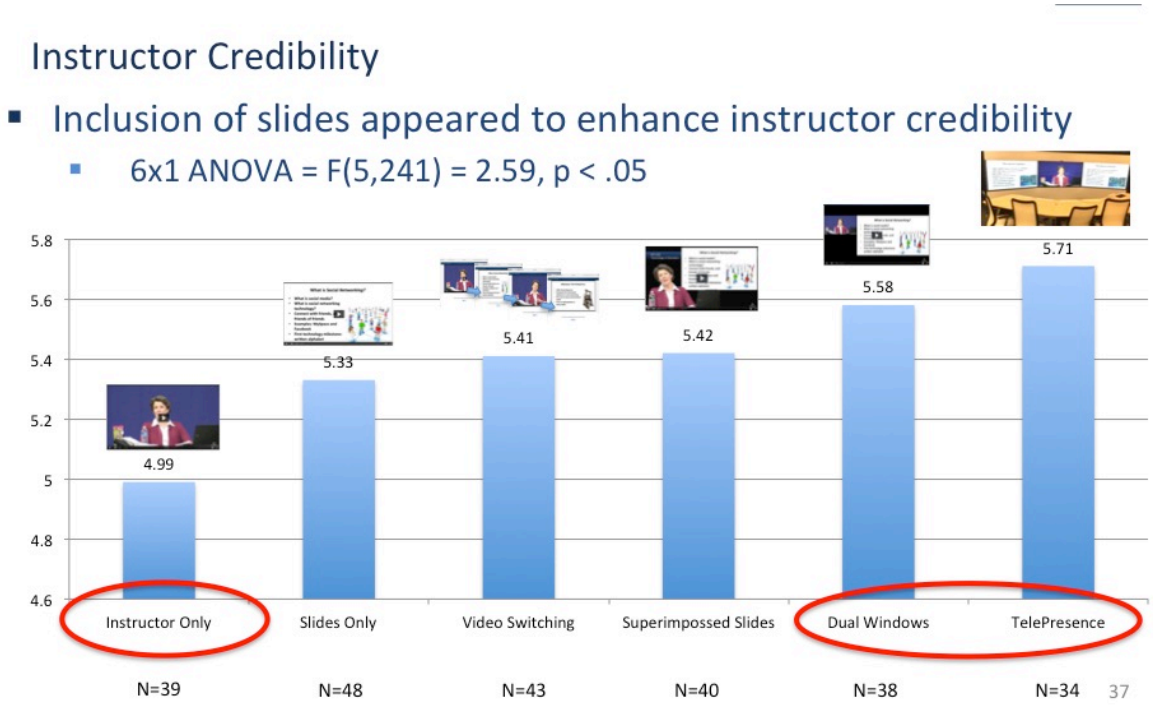

Figure 2. Significant differences were found between the Dual Windows and Immersive TelePresence groups and the Instructor Only groups in terms of enhanced perceptions of Instructor Credibility.

significant difference was indicated between the Instructor Only and the Dual Windows and Immersive TelePresence treatment groups (see Figure 2).

In terms of immediacy, the inclusion of video of the instructor appeared to influence participants' perception of communication effectiveness, $F(5, 244) = 3.63$, $p < .05$. The follow-up Turkey post hoc analysis indicated significant differences between the Slides Only group ($M = 3.83$) and the Immersive TelePresence ($M = 4.18$), Dual Windows ($M = 4.23$), Instructor Only ($M = 4.27$), Video Switching ($M = 4.29$) and the Superimposed Slides ($M = 4.37$) treatment groups (see Figure 3).

From the Instructor Evaluation Measure, students in the Immersive TelePresence treatment group appeared to be the least likely to drop the course, $F(5, 244) = 4.83$, $p < .01$. The

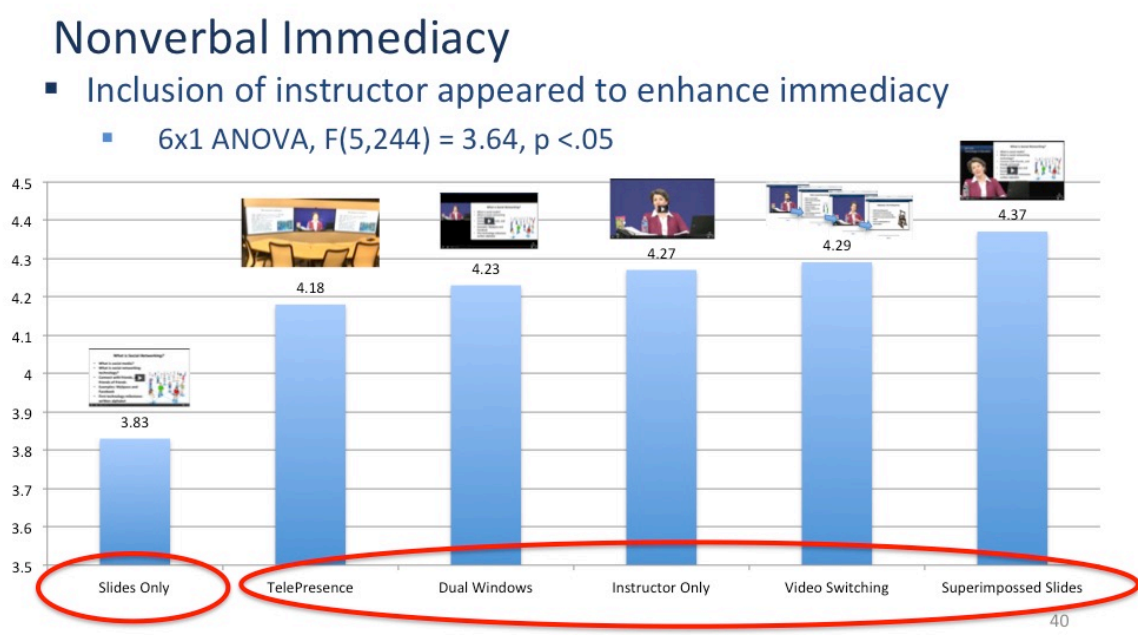

Figure 3. Significant differences were found between the other five treatment groups in the Slides Only group in terms of enhanced perceptions of Instructor Immediacy.

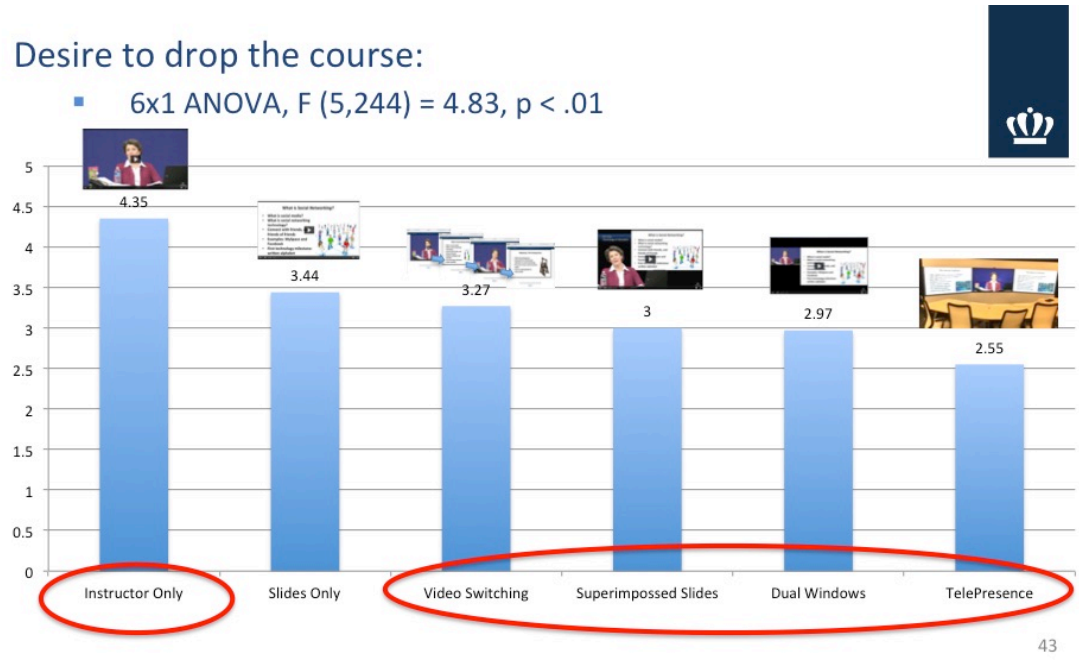

Figure 4. Significant differences were found between the four out of five groups and the Instructor Only group in terms of desire to continue the course as it was presented.

follow-up Tukey post hoc analysis indicated the statistically significant difference between the Instructor Only (M = 4.35) and the Video Switching (M = 3.27), Superimposed Slides (M = 3.0), Dual Windows (M = 2.97), and the Immersive TelePresence (M = 2.55) treatment groups (see Figure 4).

From the NASA Task Load Index, student participants rated their perception of success highest in the Immersive TelePresence treatment group, $F(5, 275) = 4.72$, $p < .01$. The follow-up Tukey post hoc analysis indicated a significant difference between the Immersive TelePresence group (M = 9.94, out of 11), and the Superimposed Slides (M = 7.6), Dual Windows (M = 7.74), Slides Only (M = 8.12), and the Instructor Only (M = 8.15) treatment groups (see Figure 5).

Finally, and also one of the items from the NASA Task Load Index, randomly assigned research volunteers rated their perception of working hard lowest in the Immersive TelePresence treatment group, $F(5,275) = 4.72$, $p < .01$. The Tukey post hoc analysis specifically indicated a significant difference between the Immersive TelePresence (M = 1.06, with a 5 being the highest perception of working hard) and the Dual Windows (M = 3.52), Instructor Only (M = 3.45), Slides Only (M = 3.41), Video Switching (M = 3.25), and the Superimposed Slides (M = 2.93) treatment groups (see Figure 6).

In addition to these survey instruments, an equivalent, multiple-choice pre-test and post-test was included to measure learning effectiveness. However, while the participants did appear to learn over the course of the video module, improvements of the post-test over the pre-test were not statically significant when the six treatment groups were compared.

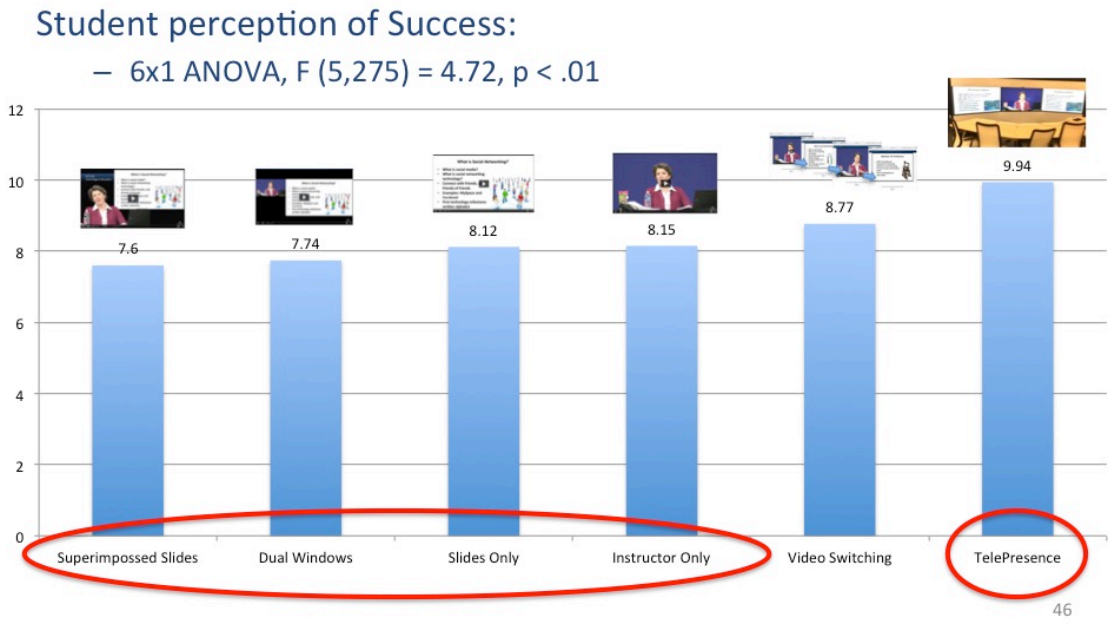

Figure 5. Significant differences were found between the four out of five groups and the TelePresence group in terms of student perception of success.

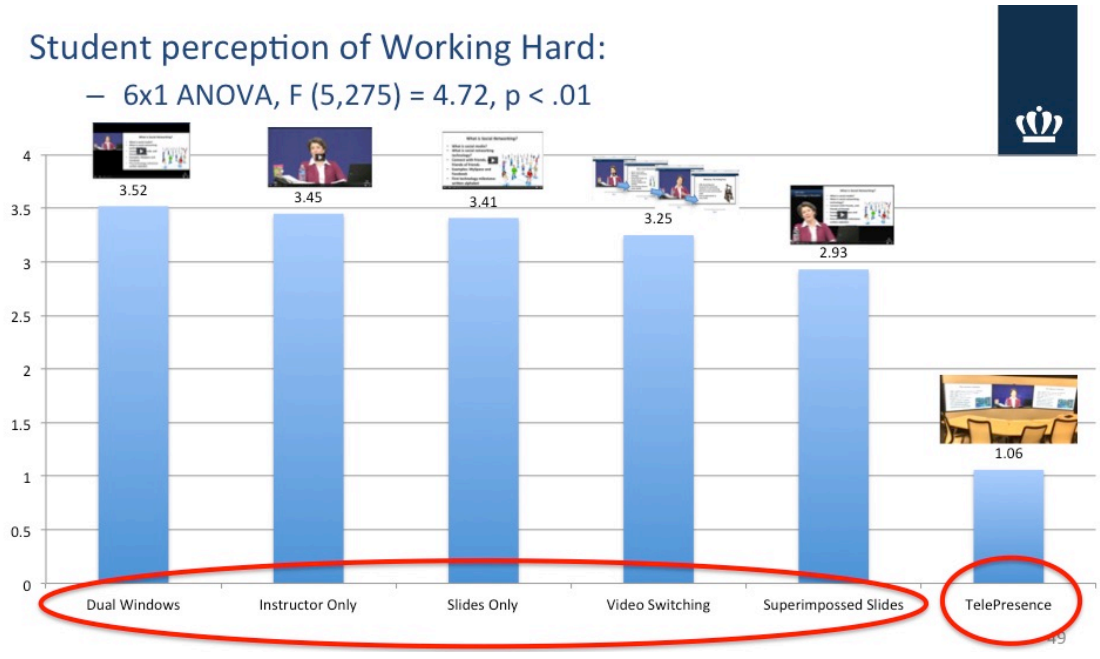

Figure 6. Significant differences were found between all five other groups and the TelePresence group in terms of student perception of general ease of the experience.

Conclusions

A strength of an experiment in practical research, as compared to quasi-experiments and qualitative research (though those research designs can also be very effective) is the random sampling and random assignment of participants. This randomization controls for age, experience, background, subject matter knowledge, and other variables by theoretically evenly distributing these variables across all treatment groups. The use of relatively large sample sizes further reduces the impact of external variables. However, given the pervasive use of multimedia, the findings in this study can be generalized and applied by many other institutions and organizations that use online and telepresence technology.

As expected, learning effectiveness or student achievement did not vary in term of the device type used to present the learning. Learning was not impacted by the specific use of smart phones, tablets, laptops, or Immersive TelePresence systems. These findings support the instructional design philosophy that the technology itself is less important than the message conveyed by that technology (Clark, 1983, 1994; Clark & Feldon, 2005, 2014; Morrison, 1994). Thus, simply comparing face-to-face learning to online learning via web conferencing or telepresence is not as relevant as comparing different multimedia communication techniques. The message design afforded by the technology is more important than the technology itself in terms of instructional systems design. However, learning can be impacted by best practices associated with technology. In this case, it appears that credibility and immediacy can be positively impacted by the inclusion of both the slides and the video of the instructor in multimedia presentations.

The affordances of Immersive TelePresence systems, such as the Cisco IX5200, appear to enhance this positive impact, especially in terms of perceived instructor credibility. The TelePresence system also performed best in terms of students' desire to continue in the course. The students appeared to appreciate the size and proximity of the three screens, the quality of the image of the instructor and slides, and the increased audio fidelity. The researchers also received anecdotal feedback that the students appreciated the power available at each seat to charge their laptops and other mobile devices, the quality of the desks and chairs, the sightlines of each display, and the general modern feel of the classroom. This feedback could also help explain the empirical results of the perception of learning success and the perception of learning ease. The students felt they learned more and that it was easier to learn in the Immersive TelePresence treatment group. These results may also be explained by the Cisco IX5200 system's ease of use. In the host university's implementation, students only have to walk in and find a seat, the system connects 15-minutes before class starts, and the students and instructor do not have to directly interact with the technology to start a class. The system may be easier to use than finding a link, logging in, adjusting video and audio, and troubleshooting when necessary; this ease of use may have a positive impact on motivation and learning.

While this study lends insight into the quantitative communication and learning effectiveness of Immersive TelePresence, the intent of this study is to create a baseline for future research projects. For instance, future research could include a live presenter, different subject matter, a longer or a shorter meeting length, allow the instructor to stand, and potentially implement eye-tracking techniques to further directly measure aspects of cognitive load. Future research will further define optimal ways to enhance immediacy and credibility in Immersive TelePresence environments.

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