Pilot Study of the Effects of Supraliminal Bipolar Primes on Occupational Educators' Viewing Time and Perceived Confidence with Desktop Virtual Reality

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Abstract

Virtual reality (VR) has been demonstrated to offer learning benefits over traditional instructional methods in many technical and occupational areas. However, in the framework of Rogers' innovation diffusion theory, adoption of VR in Career and Technical Education and occupational programs appears to be lagging. This study used experimental methodology to test the possibility of positively influencing the dispositions of occupational educators toward desktop VR through application of prime theory in a context of supplantation and technology self-efficacy theory. Supraliminal bipolar primes were used to test whether a positive disposition more conducive to VR adoption could be created in a sample of 30 occupational educators prior to introduction of a desktop VR presentation, with "disposition" defined as a pair of specific performance measures. Intended as a pilot study, this inquiry used ANOVA and correlation statistical analyses to produce sufficient indications of relationships between positive primes, VR viewing time, and perceived confidence in VR to merit recommendation of further investigation.

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Introduction and Background

Conceptual forms of virtual reality have existed since the 1920s. The technology was first introduced by the Link Corporation, which created a simulated training device for pilots called the Link Trainer. It basically consisted of an airplane cockpit set atop a pneumatic platform which was controlled by the pilot via a directional stick. The entire platform would shift in response to the pilot's control as the horizon line changed. Movie projectors would later be introduced to the device in order to provide a more realistic experience (Gladdis, 1997).

Virtual reality (VR) began to increase in popularity during the 1970s and 80s. This was in a large part due to advances in computer technology. In the early 1970s Myron Krueger coined the term "artificial reality", which was later modified in the 1980s when Jaron Lanier conceived the term "virtual reality" (Siddens, 1999). However, there is no generally agreed upon definition of virtual reality. To further complicate matters, there are numerous types of VR being developed and experimented with. These include but are not limited to artificial reality, augmented reality, immersive reality, and telepresence. The different types of virtual reality provide varying experiences in relation to immersion, interactivity, and unencumbered navigation (Krueger, 1993; Pantelidis, 1993).

The various forms of VR can be viewed as a collection of innovative ideas and instructional extensions based on the general premise or purpose of allowing the user to have realistic experience from which learning can derive. Therefore, a much broader definition for the technology was needed. Ausburn and Ausburn (2004) identified and fulfilled this need with their representative explanation:

> VR can range from simple environments presented on a desktop computer to fully immersive multisensory environments experienced through complex headgear and bodysuits. In all its manifestations, VR is basically a way of simulating or replicating an environment and giving the user a sense of 'being there', taking control, and personally interacting with that environment with his/her own body. (p. 34)

Because of substantially lower cost, training viability, and ease of use, VR formats that are not fully immersive have gained popularity. These VR formats have been identified as desktop VR (Ausburn & Ausburn, 2004; Hunt & Waller, 1999). They are generally accessed from a desktop or laptop computer and consist of a virtual reality movie that the user can control, explore, and navigate by using devices such as a mouse, scrolling ball, or glove. The VR movie can be generated with specific software packages and played in a viewer like Apple's QuickTime player. Web based environments are made available through the use of virtual reality modeling language (VRML) or as VR movies played with Flash or Java. Similar to exploring an ordinary website, individuals can access an online virtual world or movie with three dimensional images surrounding their on-screen movement.

As a learning tool, desktop virtual reality provides distinct opportunities across the educational spectrum (Dickey, 2005; Neel, 2006; Revenaugh, 2006; Shim, Kim, Park, Park & Ryu, 2003; Smedley & Higgins, 2005; Vogel, Bowers, Meehan, Hoeft, & Bradley, 2004). Secondary, post-secondary, and higher education can use virtual reality to aid in the learning process. With strong growth in distance education being provided via the Internet and DVD, a viable pathway towards integrated acceptance is present for desktop virtual reality. Even greater opportunity for effective use of VR exists when considering those students in secondary and post-secondary school systems who are being home schooled by their parents or a privately hired instructor. VR can fill a gap in the educational opportunities available to these students:

> Virtual learning plays an important role in a home-schooled student's education. The traditional homeschooler does not have many of the educational opportunities as those in public or private schools. Students in public and private schools don't always have all the educational opportunities of their neighboring districts. Virtual learning levels the playing field and provides endless opportunities for homeschoolers. (Jancek, 2001, p. 11)

An abundance of possibilities exist for virtual reality as a training tool within the career and technical education field (Ausburn & Ausburn, 2006; Park, Jang, & Chai, 2006; Seth & Smith, 2004; Tiala, 2007). Introduction to and familiarization with complex and often dangerous locational environments is often necessary in occupational preparation. Programs, courses, and training are provided in order to prepare future and current engineers, technicians, and end users on new processes, techniques, and skills. When such opportunities encounter issues in offering access to the "real thing", a highly contextualized VR option could prove beneficial. Technical skill development within professional occupations can also benefit from the technology. The medical profession is one area that is seeing measurable gains with VR over traditional methods when training surgeons (Ahlberg, Enchsson, Gallagher, Hedman, Hogman & McClusky, 2007; Ganai, Donroe, St. Louis, Lewis, & Seymour, 2005; McClusky, Gallagher, Ritter, Lederman, Van Sickle & Baghai, 2004; Seymour, Gallagher, roman, O'Brien, Bansal & Andersen, 2002).

Virtual reality is a multi-faceted tool capable of providing an increased sense of connectedness between learner and content. As education becomes more student centered and exploratory activities frequent course curricula, assistance through advanced technological applications can be expected to evolve into a standard practice. Virtual reality, with its ability to immerse learners in an environment, experience it with multiple senses, and control the pacing and flow of exploration, has the capability to transform the future of advanced instructional methodologies. Key to the movement and adoption of this instructional innovation will be continued research focused on practical development and adoption of the technology through demonstration of its specific positive effects on learning. This is especially important as some may view the technology as an alternative to traditional methods. The impetus for this pilot study came from the proposition that VR is an innovation and that the adoption of this innovation in CTE and occupational education, particularly in its cost-effective desktop form, might be facilitated if a positive disposition toward the technology could be increased in occupational educators. The study was intended as a first step in testing this proposition.

Theoretical and Conceptual Framework

The theoretical framework for this study came from three primary areas: (a) innovation diffusion theory, (b) prime theory of behavior influence, and (c) self-efficacy theory.

Innovation Diffusion Theory

Beginning with the first edition of Roger's *Diffusion of Innovations* in 1960, the theoretical foundation for research in this area was well established. Rogers' diffusion of innovation theory characterized phenomena associated with the adoption of innovative products and practices. More recently, Rogers (2003) explained that

> Diffusion is the process in which an innovation is communicated through certain channels over time among the members of a social system…a kind of social change, defined as the process by which alteration occurs in the structure and function of a social system. (p. 5)

Five types of adopters are identified within Rogers' theory, including innovators, early adopters, early majority, late majority, and laggards. Each adopter classification has a specified rate of innovation adoption based on an existing predisposition or threshold. Rogers (2003) illustrated the theoretical percentages in a bell curve shown in Figure 1. The adoption curve is characterized by symmetry where innovators and early adopters constitute the same percentage of innovativeness as the laggards, but on different ends of the curve. This represents those individuals who readily accept change and those who do not. Surry (1997) related innovation adoption theory to the range of adoption of instructional technologies in education, claiming that "Some instructional technologists blame teachers and an intrinsic resistance to change as the primary causes of instructional technology's diffusion problem" (Diffusion theory and instructional technology section, ¶ 3).

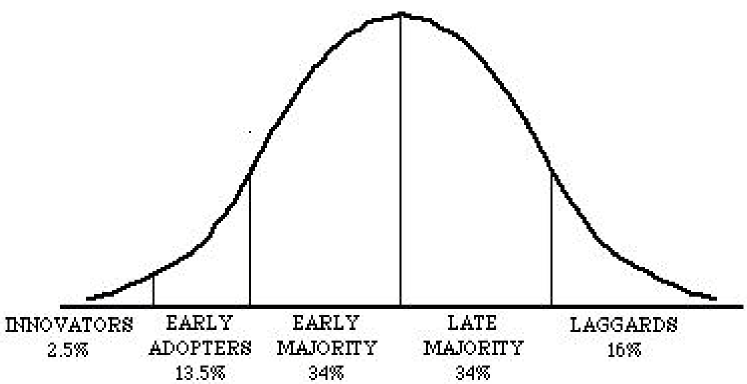

Figure 1. *Rogers' Innovation Diffusion Bell Curve*
Note. From Rogers, E.M. (2003). *Diffusion of innovations*.
New York: The Free Press.

The decision to adopt a given innovation can sometimes incur significant barriers within an educational system. Rogers (2003) addressed adoption within a system and detailed the decision types by categorizing them in three groups. First, *optional innovation decisions* "are choices to adopt or reject an innovation that are made by an individual independent of the decisions of other members of the system" (p. 28). This is sometimes seen within educational cultures that provide significant levels of autonomy concerning individual decision making. Second, *collective innovation decisions* "are choices to adopt or reject an innovation that are made by consensus among the members of a system" (p. 28). These types of decisions are often seen in organizations that use committees to guide incremental processes. Third, *authority innovation decisions* "are choices to adopt or reject an innovation that are made by a relatively few individuals in a system who possess power, status, or technical expertise" (p. 28). Organizations using a centralized approach to management tend to make these types of innovation decisions. On a practical level, the types of innovation decisions made by a given organization are not categorical and should be viewed as a continuum. Educators could be susceptible to any of

Rogers' three decision types with specific circumstantial contingency. Other factors such as social system constraints and financial caveats also play a role in an innovation decision. Thus, innovation diffusion can be systemic on many levels.

According to Rogers' theory, the vast majority of adopters (68%) reside within the early majority and late majority region of the innovation diffusion curve. Adoption by this segment could be seen to have a relationship with the observational experiences from the innovators and early adopters. "The perceived attributes of an innovation can be important considerations for those attempting to facilitate the adoption and diffusion of instructional innovations" (Gustafson & Surry, 1994, p. 23). This suggests that it is possible to modify innovation adoption by influencing perceptions of the innovation and to thus have the power of providing or effacing eventual sustainability. Further, Rogers proposed that while laggards undoubtedly affect the holistic adoption curve, it is the critical mass that determines the effectiveness of adoption. Thus significant attention is paid to individuals residing in this group by educational technologists.

Priming Theory and Supraliminal Bipolar Primes

Where innovation diffusion theory focused on adoption and how an innovation became adopted, priming is positioned more towards behavioral influence. As a concept, priming has been studied and practically implemented since the 1970s. "Researchers investigating the effect of primes on impression formation have demonstrated that mentioning traits in one context can reliably change the way that people think about a social target in an entirely different context, often without the awareness of the perceiver" (Claypool & DeCoster, 2004, p. 2). Conceptually this effect is often seen in common activities used as a social ice breaker. For example, asking an individual to stand before a group and say silk, silk, silk, silk, silk three times and then immediately asking the individual "What do cows drink?" Invariably the individual will respond with the answer "milk". It is common knowledge to the group as well as the individual that cows drink water, not milk. However, through the process of repeating the word silk several times, the individual was primed for the "milk" response. In essence, future behavior was affected for a fixed duration following the prime treatment. Bargh, Burrows, and Chen (1996) summarized the priming concept: "Priming refers to the incidental activation of knowledge structures, such as trait concepts and stereotypes, by the current situational context" (p. 230). Thus, according to priming theory, the affects of administered treatments remain for durational periods, thereby affecting future behavior. "Many studies have shown that the recent use of a trait construct or stereotype, even in an earlier or unrelated situation, carries over for a time to exert an unintended, passive influence on the interpretation of behavior" (Bargh, Burrows, & Chen, 1996, p. 230).

Several types of priming exist and have been researched or implemented within their respective constructs. Supraliminal and subliminal are the descriptors associated with the priming technique, the former being implemented for this particular study. The main distinction between the two types of priming relates to the level of consciousness between the prime treatments. *Subliminal priming* would occur below the level of individual consciousness while *supraliminal* would allow the individual to be aware of the priming stimulus but not of its intended association. Claypool and Decoster (2004) provided an explanation of the supraliminal priming technique and distinguished it from subliminal priming:

> Used originally by Higgins et al. (1977), research participants are exposed to trait primes in an initial task. Then, in an ostensibly unrelated part of the experiment, the participants are asked to provide their impression of a person or behavior. This method is known as 'supraliminal priming' because participants are made consciously aware of the primes, although not of the link between the primed construct and the object of impression. The dissociation of the primes and the target relies on the fact that participants believe that the priming and impression tasks are unrelated. (p. 4)

Claypool and DeCoster (2004) also distinguished between two other comparative priming treatments: unipolar and bipolar. *Unipolar* refers to studies where primes are related to a single trait, one primed group and a control group for example. *Bipolar*, the treatment type used in this study, “are typically related to two descriptively similar but evaluatively opposite traits” (Claypool & DeCoster, 2004, p. 5). Most often this appears with a positive prime group and a negative prime group. The analysis therefore would be deterministic of the differences between groups primed in these opposite directions.

Bandura’s Theory of Self-efficacy

When influencing a possible adoption decision confidence in the technology could be a factor. However before confidence in a technology can be gained a certain level of self-efficacy is needed. As a line of inquiry, conceptual forms of self efficacy have been prevalent since the mid to late 1960s. Albert Bandura laid the foundation for such work with his 1969 book *Principles of Behavior Modification*. He continued to inquire along these same lines with “Self-efficacy: Toward a Unifying Theory of Behavioral Change” which appeared in a 1977 volume of the *Psychological Review*. The theory base has been continually expanding and includes a 1997 book by Bandura titled *Self-Efficacy: The Exercise of Control*. Self-efficacy has thus been a primary focus for Bandura over several years. The theory has been studied by many respected scholars and applied across numerous research areas (Bandura, Delia, Taylor, & Brouillard, 1988; Bandura & Locke, 2003; Dawes, Horan, & Hackett, 1997; Hipp, 1996; Luzzo, 1994; Peterson & Arnn, 2005; Ritter, Boone, & Rubba, 2001; Thiessen, 1995; Williams, 1998; Wise, 2007). However, it is Bandura and his original social cognitive theory that is generally recognized as the foundational knowledge base from which further adaptations have derived. According to Cervone and Scott (1995), “Perceived self-efficacy must be understood as part of a much broader theoretical perspective, namely, Bandura’s social cognitive theory” (p. 356).

At its core, self-efficacy basically “refers to perceptions of capabilities for performance within a given situation, activity, or domain” (Cervone & Scott, 1995, p. 360). The theory is broad enough to be applied to multiple diverse areas. Many situations, socially driven or otherwise, that involve self-perception of an individual in association with a given outcome can be studied using Bandura's theory of self efficacy (Cervone & Scott, 1995).

Several factors, both internal and external, are said to affect self-efficacy. These include experience, social modeling, social persuasion, and physical and emotional states. These factors are also identified by various scholars as enactive experience, vicarious experience, verbal persuasion, and affective and psychological states (Cervone & Scott, 1995). While concept descriptors vary, the theoretical construct remains, thereby providing a sustainable foundational meaning.

Bandura's theory of self-efficacy has been directly applied to technology and its use or adoption (Brown, 1996; Dusick, 1998; Lumpe & Chambers, 2001; Tam, 1996; Wang, Ertmer, & Newby 2004; Webster & Hackley 1997). The principal components of the theory and its varying constructs are directly applicable to individual attempted use, and adoption of, new technology. The self-efficacy concept can be further applied toward gaining an understanding of why an individual technology is or is not adopted for instructional use. According to Wang, Ertmer, and Newby (2004), "There is substantial evidence to suggest that Teachers' beliefs in their capacity to work effectively with technology – that is, their *self-efficacy* for technology integration – may be a significant factor in determining patterns of classroom computer use" (p. 231).

Theoretical Framework for the Study

The theoretical framework for this study is shown in Figure 2 as a conjunction of innovation diffusion, priming, and self-efficacy theories. The framework conceptualizes virtual reality (VR) as an innovation and combines innovation diffusion theory, prime theory, and self-efficacy theory to form a substantive theory that priming may be able to influence users' dispositions toward VR. Figure 2 shows that priming can act as either a negative influence or positive influence on an individual's perception of VR prior to being introduced to the technology innovation. According to the framework, following a primed introduction to the VR innovation,

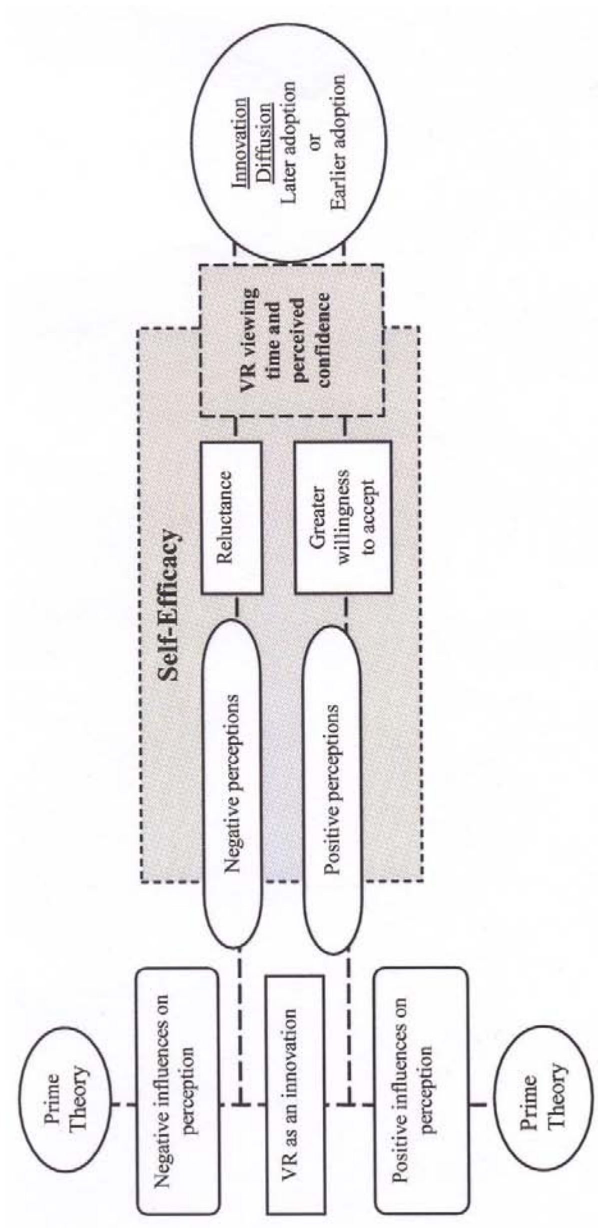

Figure 2. Theoretical and Conceptual Framework for the Study

perceptions are formed which lead to an effect on an individual's technology self- efficacy. From the individuals' various levels of technology self-efficacy may emerge either as reluctance or a willingness to accept the technology innovation. This would be observable through elective viewing time of a VR presentation and self-reported confidence in the medium. Ultimately the effects of perceptions of VR on self-efficacy would represent themselves in either later adoption or earlier adoption of the technology innovation. In essence, Figure 2 proposes that if an individual can be primed for a positive disposition toward a technology innovation (i.e., VR) which affects their self-efficacy, then they might possibly adopt the innovation earlier than would have transpired without the priming treatment. The impact of positive priming would initially be manifested in increased VR viewing time and higher levels of self-reported confidence in VR.

Many variables are present when a technology adoption decision is made on either the individual or organizational level. Rogers' diffusion of innovation theory and Bandura's self-efficacy theory illustrate the complexity underlining such variables and how they relate to individual adoption outcomes. Conservatism should therefore be maintained in gross applicability of the model shown in Figure 2 when interconnecting various theory bases to form a theoretical framework for a specific technology study.

This study is conceptualized as an experiment in influencing technology self-efficacy through the use of a specific strategy in the form of supraliminal bi-polar priming. However, it is theorized for the present study that by combining the theories discussed here, the likelihood of positively affecting the personal perception of VR and ultimately the adoption of this new innovation is high. To examine this substantive theory operationally, priming technique would be used as a tool to affect an individual's disposition which, in turn, would impact self-efficacy, thereby skewing Rogers' identified individual threshold for innovation. Thus, the theory presents a possibility of turning a potential technology laggard into a late majority adopter or a late majority adopter into an early majority adopter. Holistically, this would skew the technology adoption curve, essentially expediting the adoption process.

Research Purpose and Hypotheses

While research has shown virtual reality (VR) to be an effective instructional medium in CTE and occupational education (Ahlberg, et al. 2007; Dickey, 2005; Ganai, Donroe, St. Louis, Lewis, & Seymour, 2005; McClusky, et al. 2004; Neel, 2006; Park, Jang, & Chai, 2006; Revenaugh, 2006; Seymour, et al. 2002; Shim, et al., 2003; Smedley & Higgins, 2005; Tiala, 2007; Vogel, Bowers, Meehan, Hoeft, & Bradley, 2004), many individuals among CTE/occupational education may be resistant or reluctant to adopt this innovation. Participation in numerous educational reform movements and pressures for continual integration of emerging instructional technologies may have contributed to developing in some CTE educators a disposition toward falling into the late majority or laggard sectors of the adoption curve. This would be problematic in light of the documented high levels of success and potential of VR in technical training.

This pilot study was based on the premise that reluctance or willingness to adopt an innovation may be influenced by the creation of a negative or positive disposition. The purpose of the study was to compare the disposition toward a desktop VR presentation of CTE educators who received neutral, negative, or positive primes. If disposition can be altered then it may be possible to influence the adoption rate of a given innovation. In the context of this study, “disposition” was defined operationally as voluntary viewing time of a VR presentation and self-reported confidence level in ability to describe to others the scene presented in the VR presentation.

The study used experimental methods to test the following null hypotheses:

1. There is no difference in the voluntary VR viewing time of occupational educators who receive neutral, positive, and negative primes prior to a VR presentation.
2. There is no difference in the perceived confidence levels of occupational educators who receive neutral, positive, and negative primes prior to a VR presentation.
3. There is no relationship between VR exploration time and reported VR confidence level.

Methodology

General Research Design

This study used a quasi-experimental, posttest only design with a control group and two experimental groups. Data analysis was quantitative, using one-way analysis of variance and correlational statistical techniques.

Subjects

The sample for the study was a convenience sample of 30 occupational educators from career and technology centers as well as community colleges in Oklahoma. The sample consisted of 23 females and 7 males ranging in age from 42 to 58, with a mean of 48. The 30 subjects were randomly assigned in equal numbers (n = 10 in each group) to three non-repetitive, mutually exclusive treatment groups: (a) no prime/control group, (b) negative prime/experimental group 1, and (c) positive prime/experimental group 2.

Virtual Reality Presentation

The VR presentation used in this study was developed for a recent study of the effects of desktop VR compared to still imagery on learner performance and confidence in mastery of a scenic environment (Ausburn & Ausburn, 2006; Ausburn, et al., 2006). It was used in this study with permission of the principal investigators of the original study. The VR presentation consisted of interconnected rooms in a house that contained a complex array of visual details, cues, and interrelationships. This scenic environment allowed for exploratory autonomy by the subjects and gave each participant an equal starting point, as no subject could have previously seen the location or its content and details. Ausburn and Ausburn (2006) pointed out that the house scene was also appropriate for a generic test of VR in a CTE environment because it represented an entire class of learning tasks frequently found in technical training, i.e. mastery of positional orientation and details in a complex environment such as laboratories, shops, equipment interiors, on-site locations, etc.

The VR presentation was made via computer as a QuickTime 360-degree panorama desktop VR movie under learner control. Each learner could use the computer's mouse to move at will around the scene, click on "hot spots" to jump to various locations, and use a zoom feature to examine various details within the house rooms. This simulated walking around within the environment and moving toward and away from items within it. Each user was free to "move" as he/she chose and to visit and re-visit views and objects at will.

Instrumentation

Prior to viewing the VR presentation, each experimental group received their respective primer in the common form of a scrambled sentence test while the control group did not receive a priming test. The priming tests and procedures were taken from a priming study of social behavior by Bargh, Burrows, and Chen (1996). The priming stimuli used appeared within sets of scrambled sentences, each set being 15 sentences in length. The subjects were required to reorganize the words appearing in each scrambled sentence so that it made sense. Within each sentence test, a primer stimulus was included. Prime Experimental Group 1 received a negative prime; Prime Experimental Group 2 received a positive prime; and the Control Group received no priming.

Every third sentence in both primed groups consisted of a neutral prime which Bargh, Burrows, and Chen (1996) defined as not having any strong stereotypical values associated with it. This was done to maintain a level of neutrality. "The dissociation of the primes and the target relies on the fact that participants believe that the priming and impression tasks are unrelated" (Claypool & DeCoster, 2004, p. 4). The negative priming stimuli included the following words within its scrambled sentence test: bother, disturbing, intrude, infringed, interrupted, bold, obnoxious, bluntly, rude, and aggravating. Conversely, the positive priming stimuli consisted of the following words: respected, considerate, appreciation, discretely, courteous, polite, cautiously, patient, yielded, and graciously. The neutral primes included in both tests were exercising, successfully, normally, prepares, and occasionally. Table 1 provides an example of three scrambled sentences for each experimental group. The priming stimuli are italicized for identification purposes only, the actual instrument used in the study made no such distinction.

Table 1.
Experimental treatment examples of primes

Negative Primes	1. they her *bother* see usually 2. should now *intrude* purposely we 3. *infringe* sometimes get rights upon
Positive Primes	1. them was *respect* give always 2. from are here *considerate* people 3. can the show *appreciate* they

The dependent variables for the study were time spent voluntarily viewing the VR presentation after the priming treatment and perceived level of confidence in the VR presentation. Viewing time was defined operationally as the total time (in seconds) the subjects spent without prompting viewing the VR presentation. Perceived confidence level was defined operationally as the subjects' self-reported level of confidence on a Likert-like scale that they were capable of effectively describing the scene shown in the VR to another person. The ratings were based on a five-point scale where 1 = absolutely no confidence; 2 = a little confidence; 3 = moderate confidence; 4 = good confidence; and 5 = absolute confidence. This scale was identical to the one used by Ausburn and Ausburn (2006) and Ausburn, et al (2006) in the earlier study of VR using the house scene presentation.

Procedures

Each experimental group received their respective primer via the appropriate scrambled sentence test prior to being asked to explore the VR house scene presentation. The control group received no priming test prior to the VR presentation.

Once each experimental subject completed the appropriate primer exercise, he/she was given an opportunity to explore the desktop VR presentation on the computer. Minimal explanation was given with regard to the technology. Subjects were simply instructed to explore the VR presentation until they felt comfortable with the technology, the layout of the rooms, and their contents. While the VR exploration was in progress, a continuous timer was maintained in order to determine each subject's voluntary exploration time with the VR medium. To eliminate timing stress and avoid influence of timing knowledge on time taken, the timing was unknown to the subjects.

When the subjects acknowledged their exploratory acceptance regarding the VR presentation, they were asked to rate their confidence in being able to effectively describe the scene and its details to another person using the 5-point scale described above.

When all subjects had completed the priming activity, the timed exploration of the VR presentation, and the self-rating of confidence, all data were coded and entered into the SPSS computer program for statistical analysis with analyses of variance on the time and confidence variables, and Pearson correlation between the two measures.

Findings

Means were initially calculated for the control and experimental groups on the two dependent measures for descriptive examination. They are shown in Table 2.

The mean scores in Table 2 show differences among the three groups on both performance variables. As predicted by priming theory and literature, the negative prime group had the lowest mean, the control group exhibited the middle mean, and the positive prime group had the highest mean. Additionally, the positive prime group was the only group in which a subject reported a confidence score of 5 on the rating scale, or absolute confidence in the VR presentation. Conversely, the group receiving the negative prime was the only group to report a confidence level rating of 2, or little confidence.

Table 2.
Means for Control and Experimental Groups on Dependent Measures (*N* = 10 per group)

Variable and Group	*N*	Mean Score
VR Voluntary Viewing/Exploration Time (in seconds)		
No Prime/Control	10	256.1
Negative Prime/Experimental 1	10	245.6
Positive Prime/Experimental 2	10	301.6
Perceived Confidence in Ability to Describe after VR		
No Prime/Control	10	3.3
Negative Prime/Experimental 1	10	3.0
Positive Prime/Experimental 2	10	3.7

Further analysis was conducted for the two dependent measures using one-way analysis of variance (ANOVA). Two separate ANOVAs were conducted, one for each dependent measure. As shown in table 3, the ANOVA for VR viewing/exploration time approached the .05 significance level and showed a large effect size for the priming treatments ($F = 2.695$; $df = 2,27$; $p = .09$; $\eta^2 = .17$). However, no significant difference was found between the three groups. Although, this may be indicative of a possible trend that if variance was maintained across groups could have attained statistical significance with a larger sample, particularly in light of the obtained effect size.

The ANOVA for perceived confidence level in being able to accurately describe the house scene after viewing the VR presentation yielded a significant difference between the groups with a large effect size ($F = 4.061$; $df = 2,27$; $p = .03$; $\eta^2 = .23$). To locate which groups the significant difference occurred between, a Tukey

Table 3.
ANOVA for VR Viewing Time (in seconds)

Source	Type III Sum of Squares	df	Mean Square	F	P	η^2
Treatment	17721.667	2	8860.833	2.695	.086	0.166
Error	88783.700	27	3288.285			
Total	2257475.000	29				

R Squared = .166

Table 4.
ANOVA for Confidence (5-point scale)

Source	Type III Sum of Squares	df	Mean Square	F	P	η^2
Treatment	2.467	2	1.233	4.061	0.029	0.231
Error	8.200	27	0.304			
Total	344.000	29				

R Squared = .231

Honestly Significant Difference (HSD) test was conducted. As shown in table 5, this test revealed that the significant difference occurred between the two primed groups (HSD = .700; p = .02). The post-hoc result and large eta-squared value for the ANOVA indicated that a considerable amount of the variance between groups on their reported post-VR confidence levels was related to the priming treatments conducted prior to introduction of the desktop VR presentation medium.

Table 5
Tukey HSD Post-Hoc Test on Confidence Level Variable

(I) Treatment	(J) Treatment	Mean Difference (I-J)	Std. Error	Sig.
Control	Exp. 1	.3000	.24646	.454
	Exp. 2	-.4000	.24646	.253
Exp. 1	Control	-.3000	.24646	.454
	Exp. 2	-.7000(*)	.24646	.022
Exp. 2	Control	.4000	.24646	.253
	Exp. 1	.7000(*)	.24646	.022

(*) $P \leq .05$

As a direct measure of the strength of association between the dependent variables of VR viewing/exploration time and the subsequently reported confidence level, a Pearson correlation was calculated. The correlation value was large and statistically significant ($r = .850$; $df = 28$; $p = .00$). This correlation showed that as VR exploration times increased, so did VR confidence levels. The coefficient of determination (r^2) for this correlation was .723, indicating that approximately 72% of the variance in reported confidence levels was related to variance in VR viewing time, which indicated a strong level of association between the performance measures.

Discussion, Recommendations, and Conclusion

This pilot study conceptualized the use of desktop VR technology as an innovation. It was designed to test the researcher's substantive theory – based in priming, innovation diffusion, and self-efficacy theories – that the presentation of positive and negative primes to occupational educators prior to presenting them with a desktop VR presentation of a complex scene could affect their disposition toward this innovative technology. The study operationally defined "disposition" as time spent voluntarily exploring a VR presentation and the subsequent self-reported level of confidence in the ability to effectively describe the scene presented in the VR to another person. The major findings of the study were (a) a trend toward differences in the VR exploration time between the negatively and positively primed groups, (b) significant difference in the reported confidence levels of the negatively and positively primed groups, and (c) strong positive correlation between VR viewing time and reported confidence level.

While the small size of this pilot study makes its findings inconclusive, it did yield sufficient support for the researcher's substantive theory to merit a full-scale study using a more complex pre-test/post-test research design. Based on the findings of this pilot, it appears there could be a causal relationship between positive supraliminal priming and the amount of time occupational educators spend viewing VR presentations, as well as the level of confidence they feel regarding their ability to explain scenes they have experienced via VR. The data from this study also showed a strong relationship between length of VR viewing time and subsequently reported level of confidence in understanding of the scene presented in the VR. Given the study's findings and sequential presentation order of the primes, the VR presentation, and the reporting of confidence level, it seems possible the relationship between viewing time and confidence level may be causal, and that increased viewing time may be an outcome of the priming technique which leads to increased technology self-efficacy. It is recommended that further studies be conducted to explore these possibilities. Experimental procedures with a pre-test/post-test design are suggested to establish a chain of causality from positive priming, to increased VR viewing/exploration time, to increased perceptions of confidence in the effectiveness of VR. Other types of priming techniques and various performance variables associated with positive disposition toward VR should also be investigated.

Establishment of priming as a successful technique for favorably disposing occupational educators toward desktop VR could have important implications for CTE and occupational education. VR technology has a record in the research literature of success as both an instructional medium in technical education and as an effective workplace tool in a variety of industries (Ahlberg, et al., 2007; Dickey, 2005; Ganai, et al., 2005; McClusky, et al., 2004; Neel, 2006; Park, Jang, & Chai, 2006; Revenaugh, 2006; Seymour, et al. 2002; Shim, et al., 2003; Smedley & Higgins, 2005; Tiala, 2007; Vogel, Bowers, Meehan, Hoeft, & Bradley, 2004). For both these reasons, VR should be considered an important technology for CTE and adult occupational education. Ausburn and Ausburn (2006) also pointed to VR's efficacy at presenting the type of three-dimensional, complex scenic environment that is frequently required in CTE and occupational education. They claimed that this is a class of learning environments that is very important in CTE and that VR is an excellent vehicle for teaching mastery of that class of environments. These appear to be sound reasons for CTE and occupational education to take a leadership role in the adoption of desktop VR technology; that is, to assume innovator and early adopter roles in terms of Rogers' innovation diffusion curve, rather than settling at the late adopter/laggard end of the curve.

This pilot study was a first step in the examination of priming techniques as an agent for increasing positive dispositions toward and confidence in desktop VR technology in CTE and occupational education. If ongoing research can establish this connection, it may also be possible to advance the adoption rate of VR as an instructional tool among occupational educators – another area ripe for experimental research efforts. Additional research focused on practical applications and derived instructional advantages as demonstrated in its effects on learning is needed to further support sustained adoption. Areas of instruction that consume considerable amounts of scare resources or require access to difficult locations may benefit from the development of such initiatives. These possibilities appear to this researcher to merit further investigation. VR may be an important tool for CTE and adult occupational programs, and research into speeding its adoption may be a productive line of inquiry for the field.

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