Influence of Gender and Computer Gaming Experience in Occupational Desktop Virtual Environments: A Cross-Case Analysis Study

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Abstract

This study used a cross-case analysis strategy to compare four studies of desktop virtual environments (DVEs) to examine the effects of gender and computer gaming experience on learning performance and perceptions. The analysis confirmed in two oppositely-gendered occupationally-specific DVEs the gender effect in favor of males that is documented in the research literature. It also demonstrated a gaming experience effect in favor of more experienced gamers, but was inconclusive regarding a relationship between gender and gaming experience. Several implications and recommendations for CTE practitioners and researchers were developed.

Introduction and Conceptual Frame

Exploration and mastery of complex environments is a common feature of many CTE programs. Construction sites, manufacturing shops, animal facilities, hospitals, laboratories, emergency sites, and many other complex and sometimes dangerous locations are critical environments for CTE teachers and students, and understanding of these environments and their content is a crucial learning requirement. A new technology now available allows CTE teachers to immerse students in such environments digitally with a high degree of visual fidelity, learner control, and interactivity. These unique characteristics can create a sense of “presence” or “being there” so strong it makes learners feel they are actually inside the environment and what they are doing is actually real (Ausburn & Ausburn, 2010; Chen, Toh, & Wan, 2004; Di Blas & Poggi, 2007; Inoue, 2007; Lombard & Ditton, 1997; Mikropoulos, 2006). This new technology places high-fidelity panoramic images on conventional desktop and laptop computers. Learners can explore within an on-screen “world” as they choose. They can move around at will by panning, zooming, and using hot-spot navigation to examine specific objects, jump to different locations in the environment, and activate embedded text and video clips. These screen-based “spheres of reality” (Ausburn & Ausburn, 2010) are generally referred to as desktop virtual environments (DVEs).

While DVEs offer strong intuitive appeal and potential as a CTE instructional strategy for environment exploration and mastery, this technology has been slow to enter the instructional mainstream because of three issues: (1) technical quality and complexity, (2) cost, and (3) research challenges. New technical developments in desktop virtual reality (DVR) technology have dramatically improved the quality and “reality” of DVE’s, making them capable of remarkable presence and immersion. However, as these technologies have increased in capability, they have also become more costly and technically demanding, thus creating difficulties for research and instructional implementation. Studies with DVEs require an array of sophisticated production hardware and software, a technical learning curve, and considerable
time to design and create virtual environments for testing. The research is further complicated by difficulty finding research sites and participants and by long time frames required for individualized testing procedures.

As a consequence of these issues, studies on DVEs in CTE have generally been small in scale and hampered by methodological limitations. This has resulted in findings that are important in developing an emerging knowledge base for this new technology, yet frequently inconclusive and limited in generalizability. One way to extend the scope of small-scale research on DVEs is to employ a cross-case analysis strategy that compares results across two or more related studies to examine patterns and trends. This research strategy formed the conceptual and methodological basis for this study in its examination of learner gender and computer gaming experience in occupationally-specific desktop virtual environments.

The conceptual framework for the cross-case analysis in this study proposes direct relationships of gender and prior computer gaming experience to aspects of learners’ performance in occupationally-specific DVEs. Gender has been frequently reported in the literature as strongly related to both spatial ability and performance in virtual environments. Ausburn, Martens, Washington, Steele, and Washburn (2009) and Krouuter (2010) both reviewed the literature related to gender and performance in virtual environments and reported several reasons for differences in virtual environment (VE) performance, including visual/spatial ability, orienting and wayfinding skills and styles, computer experiences and socialization, and technology self-efficacy. The literature is mixed regarding relationships of gender with performance in VEs, and the context for reported studies has typically not been the type of occupational DVEs used in the research reported here. Several studies (e.g. Ardito, Costabile, & Lanzelotte, 2006; Jansen-Osmann, Schmid, & Hall, 2007; Vila, Beccue, & Anandikar, 2003) found most gender differences in virtual mazes and other general DVEs were related to navigation rather than to learning performance. However, the preponderance of studies have reported gender differences in DVE training success, outcome performance, and disorientation phenomena (e.g. Waller, Hunt, & Knapp, 1998a, 1998b) that may transfer to occupational DVEs. Waller, Hunt, and Knapp (1998b) reported that their studies reaffirmed earlier findings that “…understanding the spatial characteristics of VE’s [sic] may be more challenging for women than for men” (p. 4). Hunt and Waller (1999) tied gender, spatial ability, and navigational comprehension together in reporting that gender was strongly related to performance in VEs and that “…most of the effect of gender in VR spatial learning is statistically associated with differences in spatial ability…and proficiency with the navigational interface” (p. 69). They asserted that “women have more trouble with virtual environments training than men do” (p. 68). Waller (2000) subsequently claimed that the three strongest predictors of spatial knowledge acquisition in VEs were spatial ability, interface proficiency, and gender; and that the gender effect was related to the other two variables. Waller, Knapp, and Hunt (1999) observed gender differences in VE navigational interface skills and felt these could inhibit female learning in VEs but may respond positively to training. In discussing the relationship of skill and comfort with the navigational interface in VEs, Waller (2000) maintained that understanding the interface is critical for learning and that it is crucial to train users to high proficiency with the interface before they try to learn the spatial characteristics of a VE.
Jansen-Osmann, Schmid, and Heil (2007) found no correlation between computer gaming experience and wayfinding performance or spatial knowledge in virtual mazes. However, a direct relationship between comprehension and comfort with a DVE navigational interface and prior experience with computer gaming reported by Hunt and Waller (1999) and by Waller (2000) has been supported by assertions of several researchers that virtual reality is close media kin to digital gaming (Badiqué, Cavazza, Klinker, Mair, Sweeney, Thalmann, & Thalmann, 2002; Calvert, 2002). The line between a virtual environment and an interactive game may, in fact, be merely a difference in interface design (Isdale, Fencott, Heim, & Daly, 2002) and a lower level of structure and rules of engagement (Schroeder, 1997).

**Theoretical Framework**

The theoretical frame for this study is found in Cronbach and Snow’s (1977) Aptitude-Treatment Interaction (ATI) or Trait-Treatment Interaction (TTI) model. In the ATI/TTI model, learning outcomes are viewed as products of interactions of learner characteristics (aptitudes or traits) and instructional treatments in the context of a specific learning task. In this study, the TTI learner traits are gender and prior computer gaming experience; the treatments are occupationally-specific DVEs in two heavily-gendered occupations. Within these DVEs, learners are required to navigate defined virtual spaces, orient themselves in the spaces, locate items in the spaces, form mental maps of the spaces and their contents, and form perceptions of their experiences. These tasks relate directly to human wayfinding, navigation, and orientation as a theoretical foundation. Wayfinding refers to an individual’s cognitive and behavioral abilities to follow a path from a current location to a target destination through the physical movements of navigation (Darken & Peterson, 2002; Jul, 2001; Krafft, 2001). Wayfinding and navigating jointly create the ability to find one’s way to a destination. Darken and Sibert (1996) tied wayfinding to spatial knowledge. They proposed that wayfinding involves ability of a navigator to conceptualize a space as a whole and that individuals can have problems wayfinding in large virtual worlds because they cannot grasp the overall typological structure of the space. The result is spatial disorientation. Hunt and Waller’(1999) defined orientation as “… awareness of the space around us, including the location of important objects in that environment” and asserted that, “A person is oriented when he knows his own location relative to other important objects in the environment, and can locate those objects relative to each other” (p. 4). Wayfinding, navigating, and orienting have all been related empirically to spatial abilities and skills (Hunt & Waller, 1999; Lawton, 1994; Lawton, Charleston, & Zieles, 1996), which in turn have been related to gender, prior experiences, and proficiency with a virtual reality navigational interface (Hunt & Waller,1999; Linn & Peterson, 1985; Terlecki & Newcombe, 2005; Voyer, Voyer, & Bryden, 1995; Waller, Knapp, & Hunt, 1999). Further, it has been proposed that gender differences in visual/spatial skills may be exacerbated in virtual environments (Space, 2001; University of Washington, 2001; Waller, Hunt, & Knapp, 1998a, 1998b). Ausburn et al. (2009) reviewed this literature and presented a theoretical/conceptual model of complex interrelationships among variables affecting outcomes in technology environments.

These theoretical threads led to the working hypotheses for this study that both gender and prior computer gaming experience are directly related to performance outcomes in occupational DVEs, and that gender is related to gaming experience.
Purpose and Research Questions

The purpose of this study was to examine, across a set of four small-scale studies of occupational DVEs conducted by a research team at Oklahoma State University, the effects of gender and prior computer gaming experience on learning performance. The two occupations compared across all studies were both strongly gendered, but in opposite directions: surgical technology was heavily female, while policing was heavily male. All compared studies used similar DVEs created by the same research team. The opposite occupational gendering coupled with similar DVE treatments and research procedures provided a unique opportunity for comparison of trends and patterns in learning performance in occupational DVEs.

In this multi-study analysis, the following research questions were addressed through comparisons of the selected studies:

1. What is the relationship between gender and learning performance in occupationally-specific DVEs?
2. What is the relationship between prior computer gaming experience and learning performance in occupationally-specific DVEs?
3. What is the relationship between gender and prior computer gaming experience?

Methods and Procedures

Research Methodology

The methodology for this research to enable comparing and synthesizing multiple previous studies was a quantitative interpretation of the qualitative cross-case analysis (Miles & Huberman, 1994) or cross-case synthesis (Yin, 2009) technique. Miles and Huberman defined cross-case analysis as searching for patterns, similarities, and differences across cases with similar variables and outcome measures. For Yin, cross-case synthesis should involve two or more cases, which could be conducted as either independent studies or as predesigned parts of a single study, with each included study treated as a separate case for the purpose of comparison. The separate studies chosen for comparison in this research were selected because they fit Stake’s (2003) “instrumental” and “collective” criteria. According to Stake, instrumental case study provides insights into an issue or re-examines a generalization, stirring interest and promoting understanding of something else beyond the narrow specifics of any single case. Collective case study builds on a single instrumental case by extending it to several cases. Two or more cases are selected for analysis because the researcher believes that examining them collectively will lead to better understanding of an even larger collection of cases.

The studies selected for comparison in the present research had several commonalities. They were conducted by the same research team, using similar technology and quasi-experimental ATI-based research designs, included similar variables, and focused on learning outcomes in occupationally-specific DVEs in gendered occupations. While the studies were not identical and contained unique features, both their similarities and their differences were appropriate for collective analysis that could lead to cross-verification of findings and sequential
construction of patterns and trends in relationships among learners’ gender, computer gaming experience, and performance in occupational DVEs. Through collective cross-case methodology for comparing these individual instrumental research cases, deeper understanding could be gained of the empirically and theoretically related variables than could be derived from any of the small-scale studies considered individually.

The Instrumental Studies/Cases: Procedures and Findings

Study #1. This study, reported in detail by Ausburn and Ausburn (2008) and summarized by Ausburn et al. (2009), formed a baseline for the subsequent studies by the Oklahoma State University research team. User performance in a non-technical, non-occupational DVE showing the interior of a house was compared with performance in a still-color-images presentation (e.g., 8 color photos) of the identical scene. Subjects were a purposive sample of 40 females aged 18-60 and 40 males aged 18-60 from the general population. This quasi-experimental study addressed three learning outcomes: (1) scenic orientation, (2) recall of scenic details, and (3) perceived confidence in scenic comprehension. Scenic orientation was assessed with 15 multiple-choice test items that required subjects to position themselves mentally within the house scene and then identify the location of designated items relative to their own position (Hunt & Waller, 1999). Recall of scenic details was operationalized as number of items in the house scene recalled within one minute. Perceived confidence was a self-reported rating on a 5-point Likert-type scale. Testing of subjects was conducted individually in a comfortable setting of each subject’s choice, and no time limits were placed on subjects’ exploration of the treatment presentations. On two-way ANOVAs, there was a main effect for treatment in favor of the DVE over the still images. Gender main-effect findings in this study were counter to theory- and literature-based expectations of better performance and confidence for males. In this non-technical DVE presenting a familiar environment and contents; relatively uncluttered visual field; and straightforward navigation structure, the females actually performed significantly better overall than the males with moderate effect sizes in both scenic orientation and recall of details. They also tended to be more confident about their understanding of the virtual house scene. Prior computer and gaming experiences were not included in this study.

Study #2. A study described by Ausburn et al. (2009) moved the Oklahoma State University DVE research from a non-technical environment to a technical, occupationally-specific one. It also moved the research to a clinical setting with time limitations on subjects’ DVE exploration and performance testing. This quasi-experimental study used procedures and instrumentation patterned after those in Study #1. The subjects were 42 post-secondary students entering a surgical technology program in a large urban technology center. Because of the gendered nature of this occupation, the sample was heavily gender-weighted, with 36 females (85.7%) and only six males (14.3%). The instructional treatments were two versions of a DVE showing two operating rooms (ORs) full of equipment unfamiliar to the students. The DVEs were identical except for the addition in one of a small navigation map. The DVEs, presented online, were “…extremely complex visually, with many objects unfamiliar to the students, numerous labels and arrows, and complex navigation tools for moving around and examining objects” (Ausburn et al., p. 70). Outcome measures were similar to those in Study #1. They included a similar multiple-choice test (30 items) of scenic orientation, number of correct details recalled in one minute, and a self-rating of perceived confidence on a 5-point scale. A similar rating scale for perceived task difficulty was also added. Two-way ANOVAs revealed no outcome
differences related to the addition of the navigation map in the DVE treatment. However, the ANOVAs did reveal main effects related to gender. In this technically-oriented, occupational DVE, the females scored significantly lower than the males on orientation with a large effect size. They were also significantly less confident than the males with moderate effect size and found the DVE tasks significantly more difficult with large effect size. Follow-up qualitative interviews with 4 males and 15 females from the sample provided clear evidence of confusion, frustration, difficulty, disengagement, and being “lost in space” among most of the female subjects but none of the males. Additional data collected in this study but not reported by Ausburn et al. (2009) provided a measure of the subjects’ prior computer gaming experience, and were included in this cross-case study. The subjects were asked to report their level of gaming experience on a 5-point scale. Because of the relatively small sample size and the very small frequencies in some categories, these responses were collapsed to two groups: (1) never or seldom (N/S) played, and (2) played occasionally to daily (O/D). Using independent sample t-tests to compare the mean scores of these two groups, it was found that the O/D gamers were significantly better oriented in the operation rooms DVE, significantly more confident, and tended to perceive the task to be less difficult at a level that approached significance.

The relationship between gender and computer gaming experience could not be conclusively addressed with data from this study because of the very small number of males in the gendered occupation of surgical technology. However, it was observed that while the six males were evenly divided between the N/S gaming group (n = 3) and the O/D group (n =3), the 36 females had twice as many in the N/S group (n = 24) as in the O/D group (n = 12).

**Study #3.** This study, reported by Ausburn (2012), was an extension of Study #2 as a validation of the original study with a slightly larger and broader sample. To the 42 surgical technology students were added 14 more in a similar sub-baccalaureate program in a state university. This addition resulted in a total sample of 55: 48 (87.3%) females and 7 (12.7%) males. The subjects ranged in age from 18 to 45 years with a mean of 24.76 years, were mostly below 30 years of age (85.5%), and were relatively homogeneous in self-assessed levels of computer skills (fairly skilled to skilled = 81.8%). Data re-analysis with this expanded sample treated the nearly identical DVEs of the operating rooms as a single treatment and focused on performance comparison of the two gender groups and two gaming-experience groups using independent-sample t-tests. The t-tests identified statistically significant differences between males and females for DVE orientation, perceived task confidence, and perceived task difficulty. The males were significantly better oriented in the DVE than the females; felt significantly more confident in their understanding of the DVE; and felt the DVE learning tasks were significantly less difficult. The pattern of differences for computer gaming experience and the performance variables was identical to that for gender. Independent-sample t-tests found significant differences between the two gaming experience groups for orientation, perceived task confidence, and perceived task difficulty. The occasionally/daily gamers were significantly better oriented in the DVE than the never/seldom gamers; felt significantly more confident in their understanding of the DVE; and felt the DVE learning tasks were significantly less difficult. Additional analyses to examine possible relationship of gaming experience to gender were inconclusive, which was expected because the sample remained small and strongly biased in favor of females. However, simple cross-tabulations showed little evidence that gaming experience group placement was related to gender. The males were nearly equally split between
the N/S group (n = 4) and the O/D group (n = 3). While more females were in the N/S group (n = 29) than the O/D group (n = 19), these numbers did not clearly establish generalizable patterns.

**Study #4.** A study by Kroutter (2010) completes the set included in this cross-case research. Set in the context of the policing occupation, this study retained the focus on a gendered occupation but reversed the gendering to male dominance. Kroutter’s study examined the navigational behaviors and configurational knowledge acquisition of 30 police officers who explored a complex desktop virtual crime scene. The crime scene DVE contained several rooms in a house, numerous pieces of evidence, and embedded video clips presenting instructions for collecting evidence. Participants were 26 (86.7%) male officers and 4 (13.3%) females. The setting for this study was naturalistic; subjects interacted with the researcher, the DVE, and the learning tasks individually in their familiar workplace environment and had no imposed time constraints. Navigational patterns and behaviors for each subject during DVE exploration were recorded digitally using computer screen-capture software and were then coded on eight different variables (clicking, zooming in, zooming out, panning right, panning left, etc.) in multiple different parts or “nodes” in the DVE. Navigational behaviors for each subject were recorded on a movement observation log for analysis. After exploring the virtual crime scene for as long as they wished, participants were asked to draw a crime scene sketch of the virtual scene. The drawings were independently scored using a rubric on 5-point Likert-type scales for accuracy, completeness, and evidentiary detail by three experienced crime scene investigators familiar with the virtual crime scene treatment. Inter-rater reliability of the drawing scores was established with kappa coefficients (Shrock & Coscarelli, 1989). Kroutter found 14 significant differences and two trends in the navigational behaviors of the male and female officers. The females generally made more navigational moves, clicks, and cursor movements. They also took significantly longer to explore the DVE on an independent-sample t-test. However, there was no significant gender difference on the total crime scene sketch scores. These findings led Kroutter to conclude that both genders were equally able to acquire configurational knowledge in the crime scene DVE regardless of differences in navigational routes or behaviors used, given adequate exploration time. Kroutter also explored the relationship between prior computer gaming experience and behavior/performance in the crime scene DVE. He found no significant difference between officers with and without prior gaming experience on the navigation behavior variables. While the gamers did score slightly higher on total sketch scores, this analysis was inconclusive due to sample limitations. Examination of relationship between gender and gaming experience was also inconclusive.

**Cross-Case Findings**

The four studies included in the cross-case analysis had key similarities and differences that made them uniquely appropriate for comparisons to identify emerging patterns and trends related to gender, computer gaming experience, and performance in DVEs. The comparisons revealed several general findings about learner characteristics and learning performance in occupational DVEs.

**Gender and Performance in Occupational DVEs**

Across the four studies in this analysis, gender was found to be consistently related to performance in occupational DVEs in both female- and male-gendered occupations. This multi-
case comparison confirmed the findings of Ausburn et al. (2009) that were based on Studies #1 and #2 only. That study found that in the virtual house environment, the females did not exhibit the problems frequently reported in the literature. However, when the DVE changed to an unfamiliar occupational environment, the situation changed. In the surgical technology operating rooms, which were visually complex, contained numerous labels and graphic elements, and presented complex navigation interface and wayfinding requirements, the females demonstrated lower performance, less confidence, greater perceived task difficulty, frustration, and spatial disorientation. The addition of Study #3 confirmed through data re-analysis in an expanded sample the findings of female orientation problems, lack of confidence, and perceived task difficulty in an unfamiliar and complex occupational DVE. In aggregate, these studies indicated that gender performance and perception differences in DVEs occurred in occupational environments that were contextually unfamiliar, technical in content, and visually and navigationally complex. Further comparisons of the four studies suggested additional refinements of the gender learning differences in occupational DVEs. Comparisons of the settings used to present the DVEs in Studies #1 and #4 with the settings in Studies #2 and #3 suggested that gender issues occurred in clinical presentation settings but not in naturalistic settings. When DVEs were presented in familiar personal (Study #1) or workplace (Study #4) settings and conditions, females were not disadvantaged as they were when timed clinical conditions were used (Studies #2 and #3). Allowing female learners adequate time to explore and study a DVE also influenced their success (Studies #1 and #4). When adequate learning time was available in DVEs, gender differences were more related to navigation behaviors than to performance outcomes.

Computer Gaming Experience and DVE Performance

Comparison of the four studies provided some support for a positive influence of gaming experience on performance in occupational DVEs. Study #1 did not address gaming experience. Studies #2 and #3 both found that more experienced gamers were better oriented, more confident, and found learning in occupational DVEs less difficult in a clinical research setting. Study #4, however, found that in a naturalistic, untimed presentation of an occupational DVE and its interface, there was no difference in the navigational behaviors of more and less experienced gamers, and that experienced gamers were only slightly more accurate on their configurational drawings of the virtual scene. These results suggest that the relationship of prior gaming experience to performance in occupational DVEs may be similar to that of gender in a dependence on the place/time characteristics of the presentation of the DVE.

Relationship of Gender and Computer Gaming Experience in Occupational DVEs

Findings related to this relationship were inconclusive in these four studies. It was not addressed in Study #1. Studies #2 and #3 showed some tendency for males to be more experienced gamers in a female-gendered occupation, but this was not conclusive due to sampling limitations. Study #4 was also inconclusive in a male-gendered occupation.

Conclusions, Discussion, Recommendations

The findings of this cross-case analysis of four studies of gender, computer gaming experience, and learning in occupational DVEs lead to several conclusions. First, it is apparent that while gender differences in learning performance and task perceptions may not emerge in general DVEs, gender performance and perception differences may be more likely in occupational
environments that are contextually unfamiliar, technical in content, and visually and navigationally complex. This supports contentions in the research literature that females may find understanding virtual spaces more difficult than males and that gender is one of the strongest predictors of spatial knowledge acquisition in VEs. The gender effects in occupational DVEs may be complex and related to spatial abilities and interface proficiency as suggested by Waller (2000).

It can also be concluded from these studies that DVE presentation setting and time allowed for learning may be especially important for female learners. Gender issues may be more likely in clinical presentation settings than in naturalistic ones. Further, allowing female learners adequate time to explore and study a DVE may be important to their learning and confidence. This DVE place/time phenomenon was also observed in a similar study reported by Ausburn, Ausburn, and Kroutter (2010) in which a small sample of female practical nursing students experienced difficulties with a DVE showing operating rooms in a timed clinical research setting, but actually requested greater DVE complexity when learning with the same DVE was moved to a naturalistic classroom setting. Other studies have also supported this conclusion by reporting gender performance gaps when VEs were presented in clinical settings with learning time constraints (e.g. Darken & Sibert, 1996; Waller, 2000; Waller, Knapp, Hunt, 1999). Learning time in DVEs may be at least partially related to interface mastery and skills, which may be more difficult for females but may also respond to training (Waller, Knapp, & Hunt, 1999). This suggests that Waller’s (2000) assertions that understanding of a VE interface is critical for learning and requires adequate training may be particularly important for female learners.

Whatever the reasons, female learners appear to learn less effectively, feel less confident, and experience greater feelings of task difficulty in occupational DVEs when faced with unfamiliar learning settings or learning time constraints. This suggests these conditions should be avoided by CTE instructors using occupational DVEs.

A conclusion of positive relationship between prior computer gaming experience and learning performance in occupational DVEs is modestly supported by the studies examined here, but is less clear than that for gender. Several researchers have supported such a relationship due to a close media kinship of DVEs to digital gaming. It is also intuitively likely that experienced gamers would bring to DVEs a familiarity with navigational interface conventions, the “search and seek” behavior used in exploring DVEs, and the eye/hand coordination and dexterity needed to navigate in DVEs. This cross-case study partially supported this expectation, suggesting the possibility that further research may clarify the effects of computer gaming on learning in DVEs.

Even less clear from comparing these studies is the relationship between gender and gaming experience and resulting influences on performance in occupational DVEs. This relationship was not established in these studies. It may be complex and confounded by other variables such as age, spatial abilities, prior computer experiences, and interface training.

Several recommendations can be derived from this multi-case study. For CTE practitioners, it is recommended that occupational DVEs be implemented in as naturalistic a learning environment as possible; that care be taken to train learners in how to use the navigational interface; and that learners – especially females – be given as much time as they
need to understand and feel comfortable with the DVE and its interface. It is also recommended that CTE instructors using occupational DVEs watch learners for signs of difficulty, confusion, or frustration. In male-gendered occupations, observation of females should be especially careful. In female-gendered occupations, instructors should be aware that many learners may experience difficulties and need assistance.

Several recommendations are also made for continued research in occupational DVEs for CTE. Research on the nature of gender differences in DVEs should be continued in order to help CTE instructors understand how best to help all learners benefit from the capabilities of this technology. Further explorations should also be made of possible effects of other learner variables such as age, computer skills and experience, gaming and navigation interface experience, spatial ability, and preferred learning styles. Relationships among gender and these other variables may be complex and confounded, requiring interactive multi-factor research designs to unravel. Through a program of line-of-inquiry research, it will hopefully be possible to identify patterns of interacting variables that will help guide CTE DVE designers and instructors to create and implement occupationally-specific desktop virtual training environments that can bring the benefits of this exciting technology to all learners.

References


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