



# Virtual Education

## *Is It Effective for Preparing Nurses for a Hospital Move?*

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**OBJECTIVE:** The objective of this study was to compare the effectiveness of using a virtual environment (VE) versus traditional paper floor plans (FPs) to prepare nurses for wayfinding in a new hospital building.

**BACKGROUND:** This study was designed to control for variables such as task complexity and individual ability that have been missed in other media comparison studies.

**METHODS:** Thirty nurses were assigned to the VE or FP condition using a randomized block experimental design. Subjects were blocked by alternate ranks on spatial/navigational ability and computer attitude/experience and randomly assigned to conditions. Nurses received instruction with either a VE or FP condition. Wayfinding tasks were then completed with trained observers at the new hospital under construction.

**RESULTS:** The investigators found no significant differences between the wayfinding performance or post-intervention confidence levels of subjects. Instruction using both media improved wayfinding and navigation skills. Qualitative findings suggest that interactions of the instructional style, media, and learner influence information retention and transfer.

**CONCLUSIONS:** Although the virtual media did not prove to be more effective than FPs, it was equally effective for learning wayfinding and navigation skills

in a new hospital. Nursing leaders may want to consider use of 3-dimensional VEs as an early method to provide repetitive practice for learning how to navigate a new large-scale space.

On June 9, 2012, Ann & Robert H. Lurie Children's Hospital of Chicago opened as a new replacement children's hospital. One minute after officially opening, the 1st patient arrived in the emergency department and was subsequently admitted for acute inpatient medical management. Preparing 5300 employees and physicians to safely and effectively care for patients and families in a new environment was an ambitious challenge. Educational planning began in earnest 2 years prior to the move to the 23-story, state-of-art hospital offering the latest benefits and innovation in medical technology and family-friendly design. Employees, physicians, and volunteers required orientation and competency validation to the new hospital layout, safety features, new clinical technology, and workflow processes. Development of route and survey knowledge required repetitive exposure to master navigating the large-scale space. Access to the building was not possible until after construction was complete and occupancy certificate obtained. The new knowledge and skill development to be acquired in a short period was significant. For example, nurses needed to know how to operate new medical equipment, beds, and communication devices and locate supplies, equipment, and services. Orientation activities needed to occur before the move while maintaining patient care and service at the existing facility.

### *A Virtual Approach to Wayfinding*

One year before the move, the Moment One Readiness Orientation (MORO) team decided to implement a virtual approach to wayfinding and navigation. The

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The authors declare no conflicts of interest.

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team created a computerized training program called Virtual Path to the Future (VPF) to explore a realistic simulation of Lurie Children's (see Video, Supplemental Digital Content 1, <http://links.lww.com/JONA/A329>). The VPF was built in an immersive 3-dimensional (3D) environment. Through simple computer-mouse clicks, learners practiced wayfinding in a virtual replica of the new hospital. Given that no other new or replacement hospital project had reported any experience using the virtual environment (VE) for orientation, the investigators decided to research the effectiveness of the instructional medium. The purpose of this article was to report the findings from a study comparing the effectiveness of instruction using the VE versus traditional use of paper floor plans (FPs) to prepare nurses for wayfinding in a new hospital building.

## Background

### Wayfinding

Wayfinding is defined as the process by which people "orient and navigate... to accurately relocate from 1 place to another in a large-scale space."<sup>1(p117)</sup> The cognitive representation of a large-scale space is thought to develop in 3 stages as people navigate space.<sup>2,3</sup> First, the space is cognitively represented as a set of disconnected landmarks. Following additional exposure to the space, people begin to link those landmarks into routes. With *route knowledge*, a person can navigate between specified landmarks on a known route, but cannot find alternative paths to the same destination. After further exposure to the space, some people develop *survey knowledge*. Survey knowledge is a cognitive map of the space that allows for flexible navigation and a better sense of one's orientation within that space. It is survey knowledge that enables nurses to find any destination they need in a new hospital from any location and to give accurate directions to patients and families.<sup>2,3</sup>

### Media Comparison Studies

There has been a history of media studies that compare the latest media (audio, slide show, video, computer-based training, etc) with instructor-led or paper-based alternatives. Clark<sup>4</sup> performed a study meta-analysis and found no differences between media types. He noted study design flaws that included confounding variables such as instructional method or novelty. Kozma<sup>5</sup> argued that medium and instructional methods may influence the ways learners process information and may result in more or different learning when 1 medium is used compared with another, for certain learners and tasks. Joy and Garcia<sup>6</sup> identified additional confounding variables that must be controlled for in media studies: instructional method, instructor, time on task, ability,

prior knowledge, and familiarity with the instructional medium. In some studies, the tasks were not sufficiently difficult, or the metrics were not sufficiently detailed to detect differences.<sup>7</sup>

### Virtual Environment Comparison Studies

Media comparison studies have examined the transfer of learning from a VE to a real environment.<sup>8</sup> Some have found little or no difference in transfer of wayfinding skills to the real environment.<sup>9,10</sup> Others have found a positive effect for VE training.<sup>11</sup> The differences may be partially explained by the nature of the research design and the test task. For example, Koh et al<sup>9</sup> conducted a study of survey knowledge transfer to an office building space. They compared training in the actual space, an immersive VE (using a virtual reality helmet that filled the visual field), a nonimmersive VE (on a desktop computer), and using a 3D model of the space. They found no difference among the conditions. Bliss and Tidwell<sup>10</sup> compared firefighter transfer of route knowledge to an unfamiliar building following training using a paper FP, immersive VE, or no training. They found no difference between the FP and VE groups, although both did better than did the no-training group. Design and task factors may explain the no-difference outcomes. Both used simple navigational spaces and tasks, so there may have been a ceiling effect. In addition, the participants had a relatively short time on task. Bliss and Tidwell<sup>10</sup> speculated that the VE group may not have had time to acclimate to using the novel VE apparatus. Finally, neither study accounted for individual differences in navigational ability.

Banker<sup>12</sup> conducted a study of wayfinding in a complex natural environment (a large wooded area). He compared training in the real world, using a map only, and using a map and a VE. He correlated results with wayfinding ability and found that the VE plus map training produced superior wayfinding performance only for the intermediate-ability group. He found the individual differences overwhelmed training differences and that the advanced-ability group did not need the VE training to perform the tasks.

The use of VEs in nursing education has been summarized in an integrative review by de Gagne et al.<sup>13</sup> Much of the work reported is exploratory, descriptive, and technology focused.<sup>14</sup> Tschannen et al<sup>11</sup> examined the use of a VE for nursing students to provide more opportunity for deliberate practice of critical skills. The investigators found that nursing students participating in virtual simulations were able to transfer the knowledge learned in the classroom better than those not participating in virtual simulations.

A common theme in studies that found no difference between VE and other training methods was that the wayfinding task was relatively simple, whereas

those that found differences used complex tasks. This may indicate a ceiling effect; the efficacy of VE training may be revealed only when the task is complex enough. Similarly, ability can be a confounding factor. This study was designed to control for variables and factors that have been missed in other media and VE wayfinding comparison studies.

## Methods

### Setting

This study was approved by the institutional review board for investigation at a 270-bed pediatric academic medical center located in the Midwestern United States. The study was undertaken during transition planning for a move to a 288-bed, 1.25-million-square-foot, replacement children's hospital. The MORO team, composed of leaders, educators, and consultants, was formed 18 months before the move to prepare the organization for working in the new facility. The orientation to the new facility via a virtual replica of the new hospital was 1 of the 1st orientation methods deployed.

### Research Questions

How effective is instruction within a VE in comparison to instruction with paper FPs in terms of transfer of new hospital wayfinding and direction-giving skill? How does instruction in the VE affect nurses' confidence level with navigating in the new hospital?

### Study Sample

The study sample consisted of newly hired RNs who volunteered to participate in the study. Volunteers were screened for the exclusion criterion, knowledge of the new hospital layout. Informed, written consent was obtained. The research team consulted with a statistician who conducted models that predicted a sample size of 24 would produce a power of 0.80. The researchers recruited from orientation/transition programs held over a 4-month period (September 2011 to January 2012) and obtained a sample size of 30.

### Conditions

The 2 conditions for the study were the VE and FPs. Both the VE and FP classes were held at the hospital. The VE was accessed via computers with a customized internet portal to the virtual hospital built in the 3D world Second Life®. In the VE, the participants controlled an avatar by a computer keyboard and mouse interface and virtually "walked" through the replica of the new hospital building. The FP condition is where the participants were provided with paper FPs of the hospital and traced routes with a

pencil or finger. The instructional method "show and tell" was held constant across the 2 conditions.<sup>15</sup> Participants in both conditions were given equivalent time on task and the same instructor.

### Experimental Design and Data Collection

Subjects were assigned to the 2 conditions (VE and FP) using a randomized block design. Subjects were blocked by alternate ranks on the spatial/navigational ability measure scores and computer attitude/experience scores and randomly assigned to conditions. Spatial and navigation ability were determined through a self-report of sense of direction. Kozlowski and Bryant<sup>16</sup> have reported on the validity of self-report for sense of direction. The Pretest for Attitudes Toward Computers in Healthcare (P.A.T.C.H.) Assessment Scale version 2 was used to evaluate attitude levels in using computers to learn.<sup>17</sup> Kaya and Turkinaz<sup>18</sup> reported on validity and reliability testing of the P.A.T.C.H. Assessment Scale. The investigator-developed, 22-item media preassessment survey gathered data on demographics, sense of direction, prior knowledge and experience with VEs, wayfinding learning preferences, and self-assessment of wayfinding and navigation confidence levels. A weighted score of attitudes in using computers, sense of direction, confidence, and prior experience were used to assign the subjects to the conditions.

After receiving 2 hours of instruction with either the FP or VE condition, subjects completed a 12-item, investigator-developed postinstruction survey that evaluated the design, methods, instructor, and learning experience. Two days later, subjects were brought to the new hospital (under construction) to complete wayfinding tasks with trained observers. Three performance measures were used to evaluate effectiveness of the instructional media: route knowledge, survey knowledge, and direction giving. After the performance test, subjects completed an 8-item investigator-developed post-wayfinding assessment survey on instructional effectiveness and wayfinding confidence levels. A structured group interview collected qualitative data on the learning experience with the FP and VE media.

### Pilot

A pilot with 6 subjects allowed for refinement of investigator-developed instruments, procedures, data collection tools, and training of instructors and observers. As a result of the pilot, the complexity of wayfinding tasks was increased, data collection tools were revised, and the scripted directions were clarified. Based on expert consensus of the research team, the revised wayfinding tasks were deemed to be of sufficient difficulty to detect performance differences. The pilot determined a 0.93 interrater reliability for

the observers giving test directions and recording wayfinding performance data.

## Data Analysis

Statistical analyses were performed using SAS 9.3 (Cary, North Carolina). The demographics of the subjects for the FP and VE conditions were analyzed for differences using the Fisher exact test for gender, ethnicity, and academic preparation. A *t* test was used to detect differences in the mean years of nursing experience for the 2 groups. Differences in median scores for learning preferences, postinstruction satisfaction, confidence, and performance on wayfinding tasks were compared between the 2 conditions using the Wilcoxon rank sum test. For all subjects, the correlation between attitudes, computer experience, and wayfinding confidence was tested using the Spearman correlation test. Tests with *P* < .05 were considered significant.

## Results

### Quantitative Findings

The sample size was 30 with an equal division between the FP and VE conditions. During data analysis, the sample size power was recalculated at 0.38. There were no significant differences in demographics, sense of direction, learning strategies, preintervention confidence levels, and computer attitudes and experience between the 2 conditions (Table 1). The research conditions were equally matched in characteristics.

**Table 1. Sample Characteristic Significance for FP/VE Conditions**

Sample Characteristic	Significance ( <i>P</i> )
<b>Demographics</b>	
Gender	1.00
Ethnicity	1.00
Age	.83
Academic degrees	.30
Nursing experience (median years)	.79
<b>Wayfinding</b>	
Sense of direction (self-report)	.7963
Confidence (pre-intervention)	.08
<b>Learning strategies</b>	
Floor maps	.13
List of directions	.35
Walking around	.07
<b>Computer experience</b>	
Computer courses	.14
Internet	.72
Video games	.31
3D virtual worlds	.11

The instructional design, methods, and instructor were assessed after the classes were completed. Between the 2 conditions, there were no differences in the design of the instruction: pace of instruction (*P* = .80), amount of detail (*P* = .19), and amount of practice (*P* = .055, power = 0.50). There were no significant differences between the VE or FP condition in visualizing the new hospital space (*P* = .08) or learning the layout of the new hospital (*P* = .88). Both conditions helped the subjects learn the location of public spaces (*P* = .049). There were no statistical differences in the effectiveness of the 2 instructors: easy to understand information (*P* = .55), questions answered (*P* = .26), style (*P* = .86), or adequacy of preparation (*P* = .43).

The wayfinding assessment was conducted at the new hospital and included sections of patient care<sup>7,14</sup> and public floors<sup>1,11,12</sup> (Table 2). Changes in wayfinding confidence levels prior to instruction and post-wayfinding assessment were compared between the FP and VE condition and were not significant (*P* = .44). Computer attitudes were significantly correlated with wayfinding confidence levels (*r* = 0.63, *P* = .0004).

### Qualitative Findings

The nurses reported that it was helpful to see the landmarks on the public floors (fire engine, sky garden) in the virtual hospital. The virtual learning experience created a sense of familiarity when wayfinding in the new hospital. They also noted it helped being able to open doors and walk corridors to get a sense of distance when practicing in the virtual hospital. Floor plans were described as advantageous in seeing the entire floor and visualizing cardinal directions. Nurses frequently mentioned that detailed directions (eg, go past 8 offices in the administrative corridor to arrive at the President's office) were helpful in recalling directions. Active learning by trial and error in the VP or finger-tracing paths in the FP condition was noted as beneficial in remembering information.

*Research question 1: How effective is instruction within a VE in comparison to instruction with paper FPs in terms of transfer of new hospital wayfinding and direction-giving skill?*

There were no significant differences in wayfinding performance skills between the FP and VE groups. Both media were equally effective in transferring wayfinding and direction-giving skills to the new facility.

*Research question 2: How does instruction within the VE affect nurses' confidence levels with navigating in the new hospital?*

There were no significant differences in postintervention confidence levels between the FP and VE groups. Nurses did report that the VE created a sense



**Table 2. Wayfinding Performance Results**

Measure	Floor	Significance (P)
Route errors (wrong/omitted)	7.1	.81
	7.2	.37
	7.3	.85
	11.1	.09
	11.2	1.00
	12.1	.59
	12.2	.26
	14	.65
	All floors	.68
Survey errors (deviation >20 degrees)	1	.09
	7	.49
	11	.84
	12	.12
	14	.21
	All floors	.11
Direction giving (wrong/omitted)	7	.17
	11	.15
	14	.26
	All floors	.12

of familiarity with the new facility (a feeling of having been there before).

### Discussion and Implications

As in previous media comparison studies, there was no significant difference detected in performance of wayfinding and navigation skills postintervention for the FP and VE groups. Possible factors that may have contributed to these findings include the sample size and ceiling effect for task complexity. The sample size may not have been sufficient in power to detect differences. Second, while the task complexity was increased after the pilot, it may have still been a confounding factor. Task complexity was mitigated over time as the building construction neared completion. The last cohorts experienced wayfinding performance tests in a new hospital building with added landmarks, color, furniture, and signage as compared with the early cohorts participating in the performance tests. Furthermore, the effectiveness of the instructional methods may also have been a factor contributing to lack of performance differences. Both groups positively commented on the benefit of practicing scenarios by virtually exploring paths or tracing routes on FPs. The positive correlation of computer attitude/experience for both groups with wayfinding confidence was an interesting serendipitous finding.

The VE did create a sense of presence of actually being at the new hospital. Nurses commented that the nursing stations at the new hospital looked just like those in the virtual hospital. There was also a novelty factor that generated excitement and helped with the transition to a new facility. For example, 1 nurse re-

flected that while she felt silly exploring the virtual hospital with an avatar, the learning experience did take away some of the fear related to the new hospital move.

### Conclusion

While the virtual media did not prove to be more effective than FPs it was equally as effective for learning wayfinding and navigation skills in a new hospital. The findings do suggest that the interactions of the instructional style, media, and learner influence information retention and transfer. Nursing leaders responsible for hospital building orientations may want to consider use of 3D VEs as a way to phase learning over time. Virtual hospitals can be built well in advance of the construction project, allowing orientation activities to begin early, thereby easing the stress of transition to a new facility. The combination of virtual and FP media supported learning of route and survey knowledge. A virtual learning experience can be enhanced with use of virtual compasses or maps to recognize cardinal direction and location on a floor. Building a virtual hospital with high fidelity in landmarks, colors, furniture, and signage provides a simulated learning experience and augments recall of route and survey knowledge. Wayfinding and navigation of large spaces require repetitive exposure to master learning one's way around a new facility. This is usually not pragmatic or feasible when also staffing an existing hospital. A virtual hospital can be accessed to practice wayfinding and navigation multiple times before and after physical orientation visits to a new hospital building. A cost analysis reveals virtual orientations have increased development costs but provide value during implementation by reducing staff time for practicing wayfinding skills (Table 3). In the **T3**

**Table 3. VE Cost Comparison**

Real World	Virtual World
Development costs	
\$40,000	\$220,000
0.5 FTE	2.0 FTE
Instructional design	Instructional design
Tour script	Virtual build fees
Pocket guide with annotated maps	Web page/video tutorials
	Laptop computers (16)
Implementation costs	
\$530,000	\$201,000
Instructor time	Instructional time
Staff time	Staff time
Pocket guides	
Total cost	
\$570,000	\$421,000

Abbreviation: FTE, full-time equivalent.

study, setting virtual practice time was facilitated at the existing hospital 6 months before move day by setting up laptops in the patient care areas.

Future VE media studies should focus on the unique affordances of the media. Do virtual, 3D immersion learning experiences contribute to more and different learning for some learners in certain circumstances? Are there other benefits to using VEs in large-scale building projects associated with extensive training needs that have to be met in a short period for a large number of learners? Answers to

these questions can inform nursing leaders whether to invest in virtual media to support mission-critical education necessary for patient safety during transformational organizational change.

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