How Can We Ensure Transfer of Valuable Knowledge from Training in Virtual Environments

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In order to address various problems, such as increasing operational tempo and the cost of maintaining complex training platforms, military organizations are relying on simulated environments to train their personnel. Recent developments in 3D technology provide increasing training potential for virtual environments but, in order to achieve this, training must be designed so that knowledge acquired in virtual environments is effectively transferred to the real world.

But how can we ensure that knowledge transfer actually happens? How is knowledge acquired in virtual environments and what are the basic characteristics that will ensure that knowledge acquired from training in virtual environments is efficiently transferred to real world environments?

Virtual environments

Virtual environments are computer-simulated environments representing real or imaginary worlds. Although virtual environments are mostly based on visual representation, they also often include audio support. Interaction with the virtual environment is generally made through the use of standard input devices such as a keyboard and mouse but may also use specially designed devices such as head mounted displays, wired gloves or devices representing tools or interfaces used in the real environment.

One of the key advantages of virtual simulations is that they are normally less expensive than conventional simulators. They are also more portable since they can now hold on laptop computers. They also provide the possibility to train for tasks that could be risky in real life such as fire fighting procedures or expensive such as pilot training. Learners can therefore use relatively safe virtual spaces to develop spatial awareness and train for specific task they cannot safely perform in a real environment for cost or safety reasons.

Another significant advantage of virtual environments is that a single 3D model can be used for different tasks. As an example, a model of a ship can be used for spatial awareness training, console operation training, firefighting simulation and so on. All that is required is the capability to create new scenarios. As well, a single personal computer can host many software packages, allowing for substantial savings on hardware since a single computer can be used to train on different virtual environments rather than having a separate simulator for each environment.

But unless there is an actual transfer of knowledge happening between the virtual and real environments, all these advantages might just be virtual as well. If the instructional design of the virtual environment is deficient, poorly trained personnel might then become the cause of malpractices which may result injuries and incur financial costs. It is therefore important to understand how valuable knowledge can be acquired within virtual environments and how it can be transferred to real world situations.

Spatial Awareness Knowledge

According to Garrett (2007), there is little difference in the way spatial representations are formed in virtual environments compared to real world environments. But this bring the question of how are these spatial representations formed.

It is generally recognized that there are two primary types of knowledge in spatial navigation: route and survey (Sebrechts, 2000). Route knowledge refers to procedural knowledge about the movements required to get from one point to another. The acquisition of route knowledge involves learning the layout of a space by navigating into it. Local orientation is updated as the subject turns and the knowledge of the space is created through data collected from successive views. Survey knowledge, on the other end, implies a structured understanding of the layout of a space and the relationships between the elements it contains. Survey knowledge is normally acquired from outside the space through maps or plans. It is more a global representation of the space than a build-up of images.

A good everyday example of the difference between the two would be when a friend gives you directions to get to his place. Your friend provides you with route knowledge: you know the streets you need to take and when to turn but you don’t know much about what is outside this path. If instead your friend just gives you his address so you can search it on a map, you then get a global appreciation of where his house is located within the surrounding environment and you can then figure out your own way there. You then get survey knowledge.

Although navigation through a space is known to build route knowledge, it has been shown that extensive navigation leads to survey-like knowledge that is equivalent to the knowledge available from map learning (Thorndyke and Hayes-Roth, 1982). This suggests that route learning alone may be sufficient over the time to acquire both route and survey knowledge and we can therefore assume that elements of both route and survey knowledge can be acquired from computer models and expect that computer-trained individuals would have a sense of familiarity and feel confident in their ability to find their way around when they move from a virtual to a real environment. Of course, the more the virtual representation is accurate, the higher the confidence once in the real world.

Task Knowledge

But even though there are evidences that spatial knowledge can be transferred from a virtual environment to the real world, simply navigating within a virtual environment may not be sufficient to build the knowledge required to perform real life tasks. The theory of situated cognition suggests that knowledge is linked to context and, therefore, learning happens through performance across situations rather than by the accumulation of knowledge. So for learning to be transferable, the context of the virtual environment must show similarities with the context of the real world environment it represents. Therefore, for procedural knowledge to be effectively transferred from a virtual to a real environment the simulated environment must reflect the real world environment it models and learning events must refer to a realistic context.

It is however not sufficient for a problem situation to be realistic, the design of the task must incorporate a range of complex facets and options to enable and motivate students to learn from it. For Herrington (2006), the 'cognitive realism' of the task is of greater importance than the real life likeness of the learning design. This implies that high fidelity graphics and interface are less important than the design of the tasks to be completed by the learner and therefore it is not sufficient that the virtual representation of a real environment be accurate; the tasks to be performed must also be realistic in their nature and in their end results.

Herrington (2006) argues that authentic tasks are an integral component of situated learning environments. To support the construction of meaning, students must have roles similar to those found in a real world and they need to accomplish authentic activities in contexts similar to those in which these activities will be performed in the real world. In this context, peer interaction can also enhance the construction of meaning and foster the acquisition of knowledge.

Transferring Knowledge

Macedonia and Rosenbloom (2001) identified six characteristics for simulations to create realism and allow for the acquisition of knowledge that can be transferred to real situation. They are:

1. **Immersion** – The impression that a user is participating in a realistic activity. Immersion occurs when the learner, through intellectual, emotional, and normative reactions has to take meaningful actions in order to influence the state of the virtual environment.

2. **Networking and databases** – The distribution of virtual environments enables a large number of users to interact in the same virtual environment. People can collaborate and perform group tasks over networked virtual environments but in order for this to be realistic, databases must be updated frequently in order for the actions of one user, as well as the effects of these actions on the environment, to be visualized by the others.

3. **Story** – Constructivism learning theory argues that humans generate knowledge and meaning from their experiences. Success of learning within virtual environments would therefore be linked to interactions which should be designed to provide the learners with challenging experiences in which they will build new or consolidate existing knowledge.

4. **Characters** – Animated characters can play various roles in a virtual environment. They can facilitate learning by helping learners accomplish their tasks or by challenging them. In order to be efficient, their behaviour must be realistic and responsive to the user's

actions. Characters can be automated as part of the scenario or they can also be instructors or other learners interacting within the virtual environment.

5. **Setup** – The environment in which the story takes place must be realistic and provide conditions that will foster learning. Not only does the virtual environment need to be properly designed, the physical environment in which learning takes place must also be adequate.

6. **Direction** – Learners need to be guided and monitored within the virtual environment. They need to be told that what they do is right or wrong as well as understand why. This can be accomplished by an instructor observing the learners or through the use of a virtual coach providing visual or auditory feedback when the learner executes an action or completes a task.

Conclusion

In order for knowledge to be acquired in a virtual environment and to be transferred to the real world, a minimum of realism is required. This realism should be more contextual than physical, meaning that knowledge has to be acquired in a context as close as possible of the one in which the knowledge has to be applied. This can be achieved by providing learners with a simulated learning environment that resembles the work environment in which they can play their own role and where they can interact and perform realistic and meaningful tasks in realistic conditions and under proper supervision. These are, in our opinion, the conditions required for virtual environment to be efficiently used to prepare personnel to perform tasks in their real work environment.

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