The Virtual Home Modifications Educational Assistant

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ABSTRACT

This paper will introduce a new interactive virtual home that is being developed to help rehabilitation, design, and housing-field students and professionals, as well as people with disabilities and older adults, learn about home modifications and universal design. The online tool uses gaming technology. Users move an avatar with a selected disability through the virtual home, encounter barriers, and problem-solve by trying potential solutions. The system links to Assistivetech.net, a national public Internet site on assistive technology, to provide additional information about the home modifications and technology. The system has not yet been evaluated, but it is hoped that its use will provide educators, providers and consumers with a better understanding, greater acceptance and broader application of home modifications that will maximize independent living of individuals with disabilities.

BACKGROUND

Seniors and people with disabilities encounter many physical barriers in the home, including but not limited to stairs, narrow doorways, inaccessible showers and tubs, and poor lighting and visual contrast. Home modifications can remove or reduce these barriers through remodeling, adding assistive technologies and adaptive hardware, and changing the arrangement of objects. A growing body of evidence has shown that home modifications contribute to increased independence in activity, autonomy, and safety; greater confidence in performing routine household activities; prevent functional decline and disability; promote independent activity and enhance health outcomes; increase the effectiveness of caregivers; reduce the need for medical visits and decrease the likelihood of institutionalization (Allen, Resnik, & Roy, 2006; Gitlin, Liebman, & Winter, 2003; Gitlin, Mann, Tomita, & Marcus, 2001; Hoenig, Landerman, Shipp, & George, 2003; Østensjø, Carlberg, & Vøllestad, 2005; Oswald et al., 2007; Sanford & Hammel, 2006; Sanford et al., 2006; Schaie, Wahl, Mollenkopf, & Oswald, 2003; Tinetti et al., 2002).

Unfortunately, individuals who could benefit from home modifications do not always get them. The Disability Followback Survey (National Center for Health Statistics, 1999) found that over 2.5 million people with disabilities needed but had not received one of five types of home modifications (bathroom modifications, widened doors/ hallways, kitchen modifications, railings, and easy open doors). It is also estimated that only 1.14 million of the 2.1 million older households that need home modifications have them (Joint Center for Housing Studies, 2000). Part of the problem is the lack of awareness regarding home modifications. Consumers lack ready information or tools to help them make informed decisions. Meanwhile, training in home modifications is not part of the required curricula for accreditation in design, construction, rehabilitation or occupational therapy programs. The continuing education opportunities that exist are limited, are primarily in-person, and do not provide students with a way to experience home modifications. There is a need for more opportunities for training, and resources to support these training efforts.

When people are unfamiliar with the range of possible accommodations or have misperceptions about them, often the best way to learn is to experience using them. For home modifications, however, this is not always feasible. Several online "virtual" demonstration homes exist (e.g., www.build.qld.gov.au/research/virtual-tour/ and www.universaldesignhome.com), but they are presented in a static format, such as still or panned images with text, and are not designed for trying out home modifications. Perhaps the most promising is the HabiTest virtual environment research tool (Palmon, Oxman, Shahar, & Weiss, 2004). Unfortunately, it provides few options for interactivity, and it is not intended for educational use. Thus, there remains a need for a way for professionals and consumers to experience home modifications.

DEVELOPMENT APPROACH

The Virtual Home Modification Education Assistant (VHMEA) is being developed to address this gap. Our goal in developing the VHMEA is to create a system that will allow the user to interact with the virtual home and experience how a person with a disability would interact with its features. This experiential component is supplemented with textual information about different options that might be tried and their tradeoffs (e.g., cost). The system can be used independently or as part of a class. Bredeweg and Winkels reported numerous benefits to learning through interactive computer simulations, including: enhanced transfer of learning to the physical environment, removal of dangerous situations and

consequences from the learning environment that may be present in the real-world, provision of learning situations that would be too costly or destructive in the real-world environment, and the ability to repeat situations (Bredeweg & Winkels, 1998).

When using the VHMEA, system users start out by selecting an avatar with a functional limitation, and which may or may not use an assistive device (e.g., mobility aid). These avatars have varying degrees of mobility (e.g., individual who uses a walker or a wheelchair), dexterity (e.g., difficulty with grasping, reach, and/or strength), and vision loss (e.g., loss of visual field, loss of acuity). Currently, none of the avatars have multiple disabilities, but that functionality is planned. These avatars are used to interact with a three-dimensional simulation of a single-family home, complete with entrances, bedrooms, bathrooms, living room, kitchen, etc. Users have a choice of jumping to a particular area of the home (e.g., bathroom, kitchen) or navigating independently through the virtual home. Next, users can explore the impact of barriers and facilitators (i.e., home modifications) as their avatar attempts to complete specific task assignments in these areas. Finally, additional information about the home modifications can be found through links to assistivetech.net, a national public Internet site on assistive technology (AT), which contains information on over 22,000 AT products and environmental modifications.

As an example, the first home feature that many people encounter is the entrance. The VHMEA breaks the task of entering the home into several steps, including moving from the driveway to pathway (where there is a single step), moving onto a porch, freeing the door latch, opening the door, and moving through the door. Some of these steps, such as moving onto the porch, will pose barriers for some avatars (e.g., an avatar that uses a wheelchair), but not for others (e.g., an avatar with limited reach). In Figures 1 and 2, the VHMEA user was presented with the challenge of how to get up three steps onto a porch. Two of the options include installing a ramp or installing a vertical lift. Users may find that a short steep ramp is difficult to roll up, and in order to achieve a reasonable slope, the ramp might take up more yard space than desired. On the other hand, links to assistivetech.net provide them with information about the higher cost of lift options. In this example, both modifications have links to articles on assistivetech.net's ATWiki section that provide additional information.

The virtual home is being developed on the Unreal Development Kit and Unity 3d gaming engines. These tools have been used for over 50 commercial video game titles developed for PC and videogame consoles. This is in part because these platforms provide developers with the ability to simulate realistic physics, including motion/time changes. This provides a great deal of flexibility when simulating the functional traits of the VHMEA's avatars and their interaction with the environment.

Figure 1: VHMEA screen shot showing the home entrance modified with a ramp

Figure 2: Entrance modified with a vertical lift

To run the interface and experience the online environment, the Unreal and Unity clients will be made available for download by users of the VHMEA from the project's website. This download will be free and available to all users with Internet access. The system has been designed with accessibility in mind, including text equivalents for graphic and sound information and the provision of keyboard controls for people who cannot use a mouse due to fine motor limitations.

In addition, the system's platform enables up to 64 users, such as students in a classroom, to interact in the VHMEA at the same time. The online format also provides full distance learning for instructors, requiring participants only to be able to access a PC and the Internet, supporting classes of almost any size, enabling remote guest lecturers, and allowing classroom experiences to be captured and saved for later review.

DISCUSSION

The VHMEA is being developed in phases to allow for an iterative design process. As the system continues to be developed, it will be evaluated for usability and

accessibility. In addition, field tests in design and occupational therapy classrooms will evaluate how well the tool facilitates knowledge acquisition and retention. Information from these evaluations will be used to improve the tool.

When completed, the VHMEA will be usable as a training tool for college classrooms, professional education courses, or as a stand-alone training tool. It will educate professionals and consumers about home modifications so that they will be better able to make informed choices.

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