

3D Virtual Worlds: An Emerging Technology for Traditional and Distance Learning

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Abstract

Three-dimensional virtual worlds are an emerging medium currently being used as both an extension of traditional classroom environments and as a medium for distance learning. Three-dimensional (3D) virtual worlds are a combination of desk-top virtual reality within a chat environment. This review provides an overview of the following 3D virtual world applications: Active Worlds Educational Universe; OnLive! Traveler; and Adobe Atmosphere. The purpose of this review is to discuss the implications of using each application for educational initiatives by exploring the design strengths and weakness.

Introduction

During the past decade the Internet and the World Wide Web have greatly impacted the field of education. New technologies have expanded and challenged ideas of what constitutes a learning environment. Among the new offerings in emerging technologies are networked, three-dimensional virtual worlds. Three-dimensional (3D) virtual worlds are a combination of desktop virtual reality within a chat environment. While there are a variety of applications, three-dimensional virtual worlds typically provide three main features: the illusion of 3D space; avatars that serve as the visual representation of users; and an interactive chat environment for users to communicate with one another. Several of the more popular 3D virtual world applications include Active Worlds, blaxxun interactive, OnLive! Traveler, and Adobe Atmosphere.

Three-dimensional virtual worlds are relatively new; however, preliminary research indicates that they support various types of educational initiatives both as an extension to a traditional classroom environment and as a medium for distance education (Dickey, 2000). Research into the use of 3D virtual worlds as a medium for distance learning indicates that within limitations, the technology supports constructivist learning environments (Dickey, in-press). As an extension of traditional classroom environments, 3D virtual worlds offer communicative opportunities similar to that of text-based virtual worlds. Bruckman's investigation of *MOOSE Crossing* reveals that text-based virtual worlds provide an environment that supports constructivist learning by allowing for the emergence of knowledge building communities (1997). Riner's research of the educational futuristic role-playing text-base virtual world, Solar System Simulation (SOLSYS), supports many of Bruckman's findings. According to Riner educational text-based virtual worlds promote an interactive style of learning, opportunities for collaboration, and meaningful engagement across time and space, both within and across classrooms (Riner, 1996). While these findings are encouraging, 3D virtual worlds, unlike text-based virtual worlds, provide visual representations of 3D space. Research into the educational use of virtual reality (VR) argues that VR environments can be used effectively to support a constructivist paradigm of instruction (Bricken & Byrnes, 1994;

Dede, 1995; Winn, 1997). Furthermore, the inclusion of a 3D immersive environment may help bridge the gap between experiential learning and information representation (Winn, 1993).

While there is research to support the use of 3D virtual worlds as both an extension of a traditional classroom and as a medium for distance education, there are a variety of 3D virtual world applications each with varying strengths and weakness of design. Most 3D virtual world applications provide many of the same features (the illusion of 3D space; avatars that serve as visual representations of users; and an interactive chat environment), however; knowledge of how these features are manifested in the application, as well as knowledge of various aspects such as technology requirements, language support, and communication options are likely to impact the choices educators make when determining which application is most suited to individual needs.

Purpose

The purpose of this review is provide an overview of three-dimensional virtual worlds and the role 3D virtual worlds play as both an extension of a traditional classroom environment and as a medium for distance learning. Specifically this review provides (a) a review of three separate 3D virtual world applications; (b) a discussion of the strengths and weakness of each application based upon the 3D environment, communication options, and user representation; (c) an overview of the educational implications of each application.

While there are many 3D virtual world applications in various states of availability, this review is limited to three of the most prominent 3D virtual worlds: Active Worlds, OnLive! Traveler, and Adobe Atmosphere. The reason for selecting these applications is they represent a range of various design features.

Active Worlds Educational University

Active Worlds™ is one of the oldest and most dynamic 3D virtual world applications online today. The client-server application consists of the Active Worlds universe with hundreds of individual worlds for users to explore and to communicate with other users worldwide. Active Worlds is unique because it provides the option of creating user-extensible worlds in which users can add to and build in existing worlds.

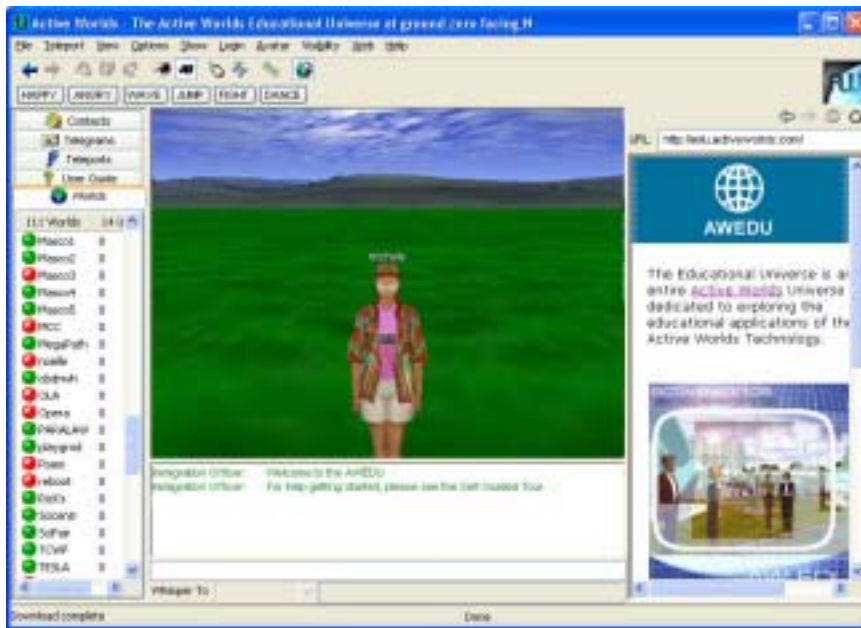
In 1999, the owners of Active Worlds created the Active Worlds Educational Universe (AWEDU), a universe devoted solely to education initiatives. The AWEDU is an educational universe with nearly one hundred individually owned, created, and maintained educational worlds. The Active Worlds Educational Universe also affords user-extensible provisions and support for building new worlds and adding to existing worlds. Educators registered as world owners are provided with a library of customizable objects from which to define and build their world.

Interface

The AWEDU browser interface is comprised of four main windows as shown in Figure 1. The center and most visually prominent window is the 3D world view in which users interact with other users and the environment and navigate through a world. Beneath the 3D window is a chat dialogue box for communication. On the left of the browser is a tabbed window that allows users to choose from a variety of extra functions for navigation, communication, and help options. To the right is an integrated web browser that allows users to interact both within the 3D environment and with web pages.

Within the AWEDU environment, users are represented by both their self-selected unique identity (i.e., alias or nickname) and by their avatar. An avatar serves as the visual representation of users currently inhabiting a particular world. Upon entering a world, users may select from a library of avatars offered by that world. Avatars serve not only as the visual representation of a user, but also as the "camera" or viewpoint into the 3D environment.

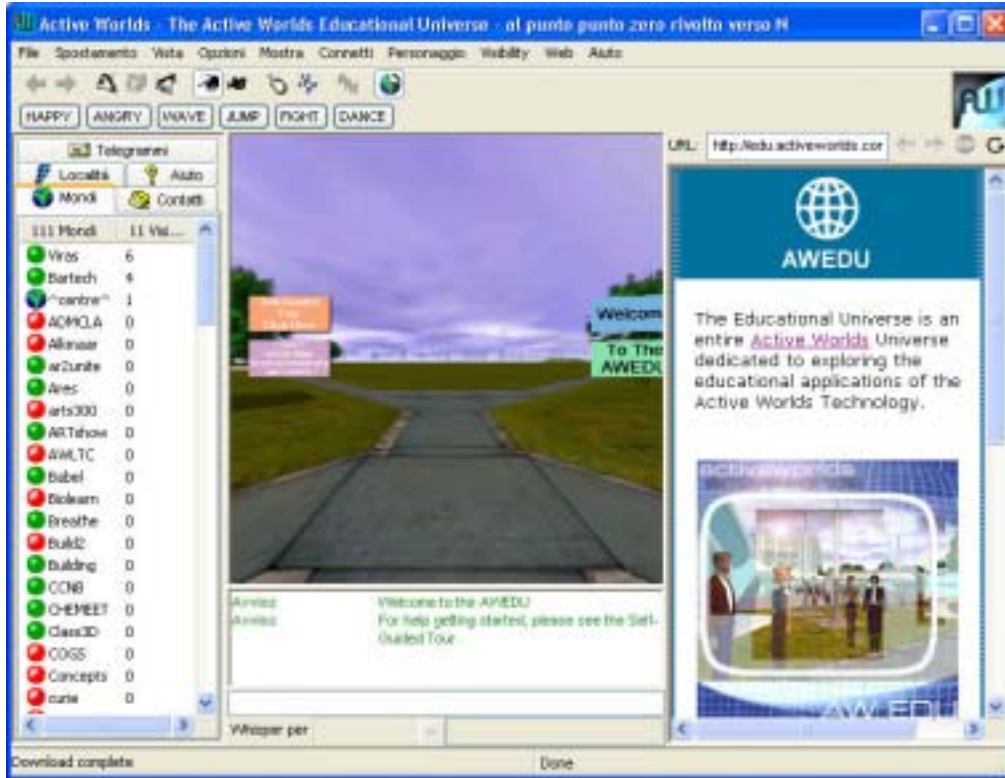
Figure 1. The Active Worlds Educational Universe Browser



Requirements

AWEDU requires a computer with a 200 MHz Pentium processor, 64MB RAM, Microsoft Windows (95, 98, Me, NT4, 2000, or XP), and DirectX 3.0. The AWEDU browser and servers can be downloaded from the Active Worlds web site (<http://www.activeworlds.com>). The AWEDU browser supports the following languages: Spanish, Danish, English, Dutch, French, German, Finnish, Italian, Hungarian, Norwegian, Portuguese, and Swedish. Despite language support, however, some of the browser features remain in English (Figure 2.). English is also the primary language used for documentation.

Figure 2. The Italian Version of the Active Worlds Educational Universe Browser



Environment

The Active Worlds Educational Universe offers much potential as a resource to extend the traditional classroom setting and as a medium for distance education. The AWEDU environment is restricted to educational initiatives and provides resources to enable even novices in 3D development the ability to quickly construct and customize a 3D virtual world. Owners have access to libraries of hundreds of objects ranging from building items such as walls, floors, and doors to household objects such as tables, chairs, and beds from which to select and customize. Owners can easily add interactive opportunities within the 3D environment by animating objects and textures and by designating sensors that trigger actions and events both within the 3D environment and by activating the integrated web-browser. Additionally world owners may also select from a pool of existing avatars to provide for users visiting their world.

World owners have options of both creating and limiting access to their world, thereby insuring privacy and security in the learning environment. Within the 3D environment they can assign or deny building privileges as well.

Communication

Upon entering the AWEDU universe, users may self-select a unique identity. No other user within the universe may use this identity. A unique identity helps establish both trust and accountability. Communication within the AWEDU environment is limited to

text-chat. Upon first *speaking* or chatting within a world, a user's name appears above his/her avatar's head. This allows users to recognize one another in the 3D environment. Chat appears both in the text-dialogue box located beneath the 3D window, and it also appears above a user's avatar in the 3D window. Users may also establish contact lists of other users. A contact list allows users to find and communicate with each other in various worlds. Users also have the option of whispering to one another if their avatars are in close proximity or they may choose to send a telegram to another user who is visiting another world.

Representation

As previously stated, users are represented in the 3D environment in the form of an avatar. Users can control their avatar to move through the 3D environment by moving along both the X and Z axis (walking and sliding). Additionally avatars can be moved along the Y axis by flying and ascending. The user may also designate looking up and down, and side to side by using key commands. Users have the choice of toggling between perspectives by viewing the environment from first-person (through the eyes of their avatar) and from third-person (orthographic). When an avatar encounters a solid object (e.g. a wall of a building) the avatar will register a slight impact and be prevented from moving through the wall. World owners and builders may also adorn the environment with sensors and triggers. A user's avatar encountering a sensor or trigger, may activate a variety of pre-specified actions such as being transported to a new location or world, activating a sound file and animation or even activating a webpage to load in the integrated web-browser.

Educational Implications

Learners are embodied in the 3D environment in the form of an avatar which allows them to interact with the environment and with each other. In keeping with the current focus on inclusion and diversity in the learning environment, it is important to address how any educational medium supports or inhibits inclusion and diversity of the participants particularly in collaborative learning environments. With regards to diversity, AWEDU is problematic in the ways the design limits users ability to control representation (Dickey, 2002).

One area that deserves closer scrutiny is how AWEDU might be intended for use. This may not be suitable as the primary medium for a lecture/discussion style class. Differences in typing skills may disadvantage some students. Additionally, differences in written language skills might also serve as an impediment for other students. Granted in a traditional classroom, differences in communication skills advantage some students over others, however, a traditional classroom also offers a wider range of avenues for non-verbal communication. Although there is indication that AWEDU does offer a degree of embodiment within the design, it does not allow for the variety and complexity of non-verbal communication as is available in a face-to-face setting.

There are already many educational initiatives within the AWEDU universe ranging from informal training for new users, to using AWEDU as a distance education medium for university level courses (Dickey, 2000). The flexibility afforded by AWEDU makes it

suitable for a variety of subjects including foreign/second languages, science, communication, language arts, as well as many others.

While it is important to address weakness in such areas as diversity and inclusion, it is important to note that AWEDU is an emerging technology and in a constant state of revision. Informing designers of the weaknesses is part of the process of insuring that emerging technologies include the type of design features that support the needs of all learners.

OnLive! Traveler

In early 1996, OnLive! Technologies launched OnLive! Traveler. OnLive! Traveler is the first 3D virtual world technology to support multi-user, synchronous, audio communication. By speaking into microphones, users speak to one another in a real-time 3D-chat environment. Users in the 3D environment are represented by avatars, however, unlike other 3D virtual world applications, Traveler avatars are *talking heads*. The Traveler avatar heads have life-like facial gestures (blinking eyes) along with lip-syncing motion that accompanies real-time voice communication. The heads range from fantastical masks and characters to animals. During the development of OnLive! Traveler, the decision was made to initially use only heads because "the designers wanted to establish a human-to-avatar bond" (Wilcox, 1998). According to Traveler designer Steve DiPaolo the goal was to establish a sense of telepresence by "bind[ing] the real person at the computer with his or her virtual avatar in cyberspace" (as reported by Wilcox, 1998). As a result, Traveler avatars with their life-like facial gestures and lip-syncing motion provide a provocative if not eerie sense of embodied presence in the 3D environment.

Interface

The Traveler interface consists of a main browser and several detached windows. The main browser window is a 3D world where most of the interaction and communication takes place (see Figure 3). Other optional windows can be activated to provide information about who is currently visiting a particular world and where to locate them.

OnLive! Traveler requires a Pentium computer, Windows 95 or NT, 16 MB of RAM, a SoundBlaster 16 or compatible 16-bit sound card, an Internet connection (minimum-28.8 modem), either Netscape or IE 3.0 or higher, and a microphone. Because Traveler allows for real-time voice, users are not restricted by the same limits imposed in an all text-based environment. Any language can be spoken in a Traveler setting, however, the browser and most downloading instructions are in English. A user must either have the English language skills or have access to a translator in order to download and launch the Traveler browser. OnLive! Traveler may be downloaded for free from the Digital Space Commons Corporation website (<http://www.digitalspace.com/traveler/>).

Figure 3. The OnLive! Traveler Browser



Environment

Traveler worlds are primarily based on Virtual Reality Mark-up Language (VRML) and are limited in size and functions. For the most part the environment serves to support the interaction between users. Development of worlds is not readily assessable to 3D modeling novices.

Traveler worlds, like most VRML scenes, are not very large and the worlds have edges and limits. Users can actually fall beneath the world's floor. When a user's avatar encounters a designated solid object or another avatar and collides, there is a collision sound and the avatar bounces off the object or avatar simulating collision. This is reflected from the first-person perspective. It is not uncommon to be speaking with another user, when suddenly one's avatar is bumped by another avatar and bounced across the world. From the user's perspective, this action is similar to being bumped or pushed in the real world. While there are limitations, the first-person perspective and lip-synched avatars make for an interesting and embodied virtual world experience.

Representation and Communication

Like AWEDU, Traveler limits users to a selection of pre-existing avatars; however, the Traveler avatars are customizable. Users have the option of selecting colors from an existing palette and changing the color of groups of polygons on an avatar. Additionally, users have the option of altering their avatars by stretching or squashing the shape. Users may also opt to select from a variety of emotional states (angry, happy, surprised, and sad). One other option that is worth noting is that users may also select the vocal range they wish to project.

The construction of embodiment is one of the most interesting aspects of Traveler. Given the fact that most of the avatars are heads, embodiment may seem limited. However, that

is not the case. While there are no limbs, or even torsos, Traveler provides more of an embodied experience than most other 3D virtual worlds. The use of real-time voice, coupled with the ability of the software to interpret voice data and translate it into vocal movement adds greatly to the user's sense of embodiment by allowing users to see and hear one another. In addition to the real-time voice, the use of such features as collision reinforced with sound effects provides a sense of physical awareness that is rare to 3D virtual worlds. In some sense, there is a kind of physical accountability that comes with the simulation of physical resistance and impact. Though a user has no impact on the simulated physical environment, there is consequence to colliding with a solid object or another user.

In addition to the real-time voice and collision feature, Traveler also reinforces a sense of embodiment by how shifts in perspective and collision are reflected in the user's perspective. While it is not unique that navigational motion is reflected, it is unusual that collision and impact is reflected. When we are jostled or bumped in life, we know not only from the physical impact, but it also registers visually. While Traveler does not yet have the capacity to register impact physically by way of physical body sensors, it does allow users to register visual changes. One last aspect in which Traveler constructs the user's sense of embodiment is by the overall lack of the text-dialogue box. Instead of users having to continually shift focus between two windows, most of the action and communication is situated in the 3D environment. This greatly enhances not only the sense of embodiment, but also the sense of being present in that environment.

Educational Implications

With any potential educational medium, it is important to address issues concerning the diversity and inclusion of all learners, but is particularly important for collaborative learning environments. Traveler offers a great amount of freedom and control over user representation. While users are limited to a selection of avatars, this selection does not represent any particular bias of gender, ethnicity, age, or race. For the most part, the avatar selections are fantasy-types and users are able to customize both color and shape.

While Travelers allows for a great degree of control over visual representation, the lack of user-extensible features limits some of the potential use as a learning environment. Communication is the key asset of Traveler, however, ironically it is not well suited for lecture/discussion styled activities. While it allows for real-time voice, and a relatively fair degree of embodiment for users, discussions may still prove to be problematic due to the lack of turn-taking provisions and non-verbal gestures usually afforded in a traditional classroom environment.

Traveler has been used for various educational initiatives, but primarily as an exploratory medium for groups studying the design of 3D virtual worlds and communication tools. For the most part, Traveler has found a niche in the 3D virtual world market primarily as a social environment.

Adobe Atmosphere

In 2001 Adobe launched Adobe Atmosphere, a tool for 3D virtual world authoring and interacting. Adobe Atmosphere consists of two main tools: Atmosphere Player, which comes as both a stand alone browser and a Web plug-in, and Atmosphere Builder. Atmosphere Player allows users to view and interact within Atmosphere worlds and to communicate with other users. Atmosphere Builder allows users to build unique worlds. The underlying technology for Atmosphere Player provides support for complex lighting and texture display. Atmosphere worlds are not centrally hosted, but rather individual users can create and host worlds upon individual servers. Worlds can be linked to each world to maintain continuity in the immersive experience. Currently both Atmosphere Player and Builder are free to download from the Adobe website (<http://www.adobe.com/products/atmosphere/main.html>).

Requirements

Atmosphere Player requires a Pentium processor, 32MB RAM, Microsoft Windows (98, 2000, Me, or XP). It also requires 14MB of hard-disk space, 16-bit color, at least 56K modem, and Internet Explorer. Atmosphere Builder has the same requirements, but with an additional 50 MB of available hard-disk space and 1,024x768 screen resolution. Adobe provides limited language support in the form websites with instructions and downloads information in various languages.

Interface

The stand alone Atmosphere Player interface consists of three scalable windows (see Figure 4). The visually most prominent is the 3D environment in which users move and interact. Directly below are various icons for navigation and communication. Beneath the icons is the chat box for communication. To the left of the Player browser is a tabbed window with additional controls and options.

Figure 4. Adobe Atmosphere Player



Environment

Adobe Atmosphere offers much potential for developing unique environments for learning. Atmosphere Builder allows novice 3D developers (and educators) means to create compelling 3D environments. The Builder tool provides a selection of predefined basic geometric objects for builders to combine, manipulate, and customize to form objects in the environment. For more sophisticated environments, Builder allows developers to designate lighting controls, import and add textures to objects, add sound, and create interactive opportunities by embedding JavaScript commands to objects within the environment. Additionally individual objects within the 3D environment can be linked to Web pages allowing users to view text and image information supplemental to the 3D environment. Like OnLive! Traveler, Atmosphere worlds have edges and limits; however, developers may also embed portals within a world so a user may move seamlessly between worlds. While users do not have the option of adding to or building in an existing world, the availability of Atmosphere Builder affords users/students an accessible means of building their own worlds.

Communication

Communication within the Atmosphere environment is text-based chat. Worlds may be chat enabled or disabled. Because worlds are not centrally hosted, users do not have the availability of using unique identities. On one hand this allows users more flexibility in representation, yet on the other hand, it decreases user accountability and trust. There are no contact lists such as those afforded by AWEDU or provisions for contacting users currently visiting other worlds; however, there are options for whispering to users currently visiting the same worlds.

Representation

Users in an Atmosphere environment are free to represent themselves as they choose. Because Atmosphere worlds are not centrally hosted, but rather worlds are hosted on individual servers, a user can create and use her/his custom-made avatar by having his/her avatar stored on a web server. Within the Atmosphere Player interface, a user can designate the URL of his /her avatar. This in turn allows users to both control their visual representation and to be recognized within an environment based upon that visual representation. However, it is interesting to note that in order to determine the identification of individual avatars; users must look in the tabbed window called *Users*. The *Users* window lists all of the users currently inhabiting a world and a small image of their corresponding avatars (see Figure 4).

Like Traveler and AWEDU, Atmosphere users may move along the X and Z axis. Unlike Traveler and AWEDU, users may specify whether to activate collision rather than the world's owners controlling that option. Users cannot control moving along the Y axis, but they may activate the gravity option which allows an avatar to float above the surface of the ground.

Educational Implications

Although Atmosphere is a relatively new application, it has already generated educational initiatives ranging from design classes exploring it as a medium to collaborative projects

for NASA. While it offers much potential as a medium for distance education, the lack of unique identities may limit its suitability for some educational initiatives.

One feature particular important for educational use that Atmosphere provides is the ability for users to create their own avatars. Within a constructivist learning environment, the ability to take on other roles and in turn develop multiple perspectives greatly enhances the learning process. One of the goals of a constructivist learning environment is to find activities that support "dialogical interchange and reflexivity" (Duffy and Cunningham, 1996). Allowing users to self-define their representation in the 3D environments, affords potential learners opportunities to try new roles and perspectives.

Discussion

Environment

Out of the three applications, Active Worlds Educational Universe provides the easiest methods for creating and maintaining individual worlds. The pre-fabricated objects allow users to merely select and place objects. While customizing objects is limited, users may still add unique textures and animated textures. Interactive opportunities are also to some degree limited to a pre-defined choice of options, however, they are easy to employ and add to an object or environment. Atmosphere on the other hand, allows for more diverse and unique environments. Because worlds are not centrally hosted, users are free to define their worlds in any way they choose. However, Atmosphere, while much easier to use than most 3D modeling programs, still requires developers to create most objects from combining and manipulating pre-defined geometric primitives (e.g. sphere, cube, tube, etc.). While this is not difficult, it does require a greater investment of time and energy. More interactive opportunities are also possible with Atmosphere; however, it does require developers to have some knowledge of JavaScript. The result of creating a world with Atmosphere is a world that is a more uniquely customized, but there is a greater investment in the design and development.

Communication

Of the three applications reviewed, OnLive! Traveler provides the most intuitive communication opportunities because it relies upon voice. The lip-synched floating avatar heads affords a degree of embodiment unparalleled in most 3D virtual world applications. AWEDU and Atmosphere rely upon text-based chat which while supporting communication, also tends to draw the user's attention away from the 3D environment.

Both Traveler and Atmosphere allow users to create, change, and alter their identities. While AWEDU also allows for changing identities, a user cannot use the same name as another user. This prevents one user from impersonating another. The provisions of providing contact lists and maintaining unique identities affords the development of trust among users and accountability within the environment.

Representation

The three applications in this review represent a range of user visual representation. AWEDU is by far the most restrictive with users being limited to a choice of pre-selected avatars. While Traveler also limits users to a selection of avatars, users have the options of customizing their avatars. Atmosphere affords users the greatest flexibility in the 3D environment because they are free to construct their own representation. Avatars may be created using Atmosphere Builder or with third-party software such as Curious Labs' Avatar Builder.

Conclusion

All three virtual worlds displayed various design strengths and weaknesses. While AWEDU offers the greatest support for user-extensibility, the avatars are problematic. Atmosphere offers the greatest degree of user control over representation, yet offers very limited opportunities for adding to and building within existing worlds. The communication features offered by both AWEDU and Atmosphere are fairly similar, but offer varying degrees of user control. Traveler was the only virtual world in this review to employ the use of real-time voice and out the three virtual worlds provides the most interesting study of how embodiment can be constructed and supported in the 3D virtual environment. Yet, Traveler is by far the most limited in design suitability for education. It should be noted that this review is neither comprehensive nor exhaustive. The educational context and purpose should determine the selection of an appropriate 3D virtual world application. While all three applications presented in this review afford varying strengths and weaknesses for educators, the introduction and use of a 3D virtual world offers innovative and unique educational opportunities for both traditional classroom environments and as mediums for distance education.

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