MOONWORLD: VIRTUAL FIELDWORK IN SECOND LIFE. L. Ruberg, C. A. Wood, D. D. Reese, C. Lightfritz and A. Harrison, Center for Educational Technologies, Wheeling Jesuit University, Wheeling, WV 26003 (chuckwood@cet.edu).

Introduction: Second Life (SL) is a persistent virtual world in which avatars explore a three-dimensional landscape [1]. Learners can guide their avatars to walk or fly through the world, interacting with it and other avatars. We are developing *MoonWorld,* a simulation that models the surface of the Moon in SL, as a tool for learning lunar science through virtual field work. *MoonWorld* will engage avatars in authentic scientific inquiry as they seek solutions to selenology challenges. The immersive SL affordances cannot be duplicated in a classroom nor with a normal website, making *MoonWorld* a new approach to experiential learning. And ideally it will be fun.

Design: Following the same approach as our previous lunar formation video game *Selene* [2] we will start by identifying the instructional goals and specifying the targeted concepts. Sample goals include using evidence gathering and analysis to understand how impact craters form and how their spatial relations with other landforms permit development of a stratigraphy and history.

The *MoonWorld* island – actually in the SL sky, like a real Moon – will depict lunar impact craters and volcanic features with geologic characteristics and interrelations that can be discerned through careful observation and measurement. For example, clues to the formation of an impact crater will come from sampling rocks exposed along the crater rim and central peaks. Walking down the inner walls will reveal – to a careful observer – terraces with fault scarps and ponded impact melt, evidence that the crater was modified by wall collapse and splashed by late stage melt.

Nearby features will include lava flow fronts that cover some of the crater's secondaries, establishing a stratigraphic relation. A sinuous rille, volcanic dome and a dark halo crater will offer chances to understand volcanic landforms, but include a trick, for the dark halo results from an impact crater excavating buried mare lava. The lava flows will be modeled after the fresh ones in western Mare Imbrium, and avatars will be able to climb into the sinuous rille and onto the dome and dark halo crater to investigate their morphologies.

The main feature of *MoonWorld* will be modeled after Timocharis, a 33 km wide lunar crater in Mare Imbrium. This crater was selected because it is a small diameter example of a relatively pristine complex crater with central peaks, terraces and secondary craters fields. A smaller simple crater will also be available to gain experience with the change in morphology with diameter. Timocharis was selected also because there are high resolution Apollo Metric photographs and a LTO topographic map [3] to provide excellent detail for the *MoonWorld* landscape. Unfortunately, a SL island is only 250 m on a side so the crater has to be scaled down by a factor of a hundred or more to fit! This actually is an advantage because it makes the experience more compact and visually interesting.

Avatars who visit *MoonWorld* will teleport into a lunar habitat where they will be issued a spacesuit before they can go through the airlock to the lunar surface. In addition to being a cool piece of clothing the spacesuit will give the property of reduced gravity to better emulate the real Moon, and will contain a jet pack for flying. The spacesuit also will accept different strap-on instrument packages such as magnetometers, gravimeters and multispectral imagers, and a heads up display to visualize those measurements in real time. This is not yet available in the real world, but will make it easier for learners to recognize correlations between geologic and geophysical properties.

Lunar Habitat: Although the main focus of *MoonWorld* is understanding how scientists learn about lunar geology, a secondary interest derives from one of our previous projects relating to living on the Moon. *BioBLAST* [4] is an integrated educational model for a biologically based human life support system, derived from NASA advanced life support research data. Three simulators provide graphical interfaces to mathematical models of plant growth, human requirements, and resource recycling systems. A fourth simulator integrates all three components to allow the learner to test how long their plant-based model could support a human crew on the moon When *BioBlast* was published in 1999 it used QuickTime Virtual Reality to look at various parts of a lunar base from different perspectives. Now with SL, a learner's avatar can be within the scene and naturally interact with it by looking, walking and touching.

MoonWorld Audience: MoonWorld is an informal educational environment available to anyone who wants to learn about the Moon through virtual interaction on a simulation of its surface. It is open-ended problem-based exploration. Most visitors will embark on a challenge, following a gently guided trail, with Mission Control asking questions to encourage observation and analysis of morphological features to understand how various features formed. Other scientists and educators who would like to add activities to *MoonWorld* are invited to contact us.

Anticipated Outcomes: The process of designing, developing, and testing *MoonWorld* in SL will provide useful information regarding the effectiveness of virtual worlds as experiential learning environments. The results of our testing will tell us to what extent the virtual experiences offered in *MoonWorld* result in meaningful learning. Additionally, we hope that *MoonWorld* will become a successful tool to help learners of all ages experience and understand the Moon that is becoming increasing visited by spacecraft and soon (but not soon enough) humans.

References: [1] Linden Research, Inc. (2009) http://secondlife.com/whatis/. [2] Reese, D. D. (2008). GaME design for intuitive concept knowledge. In R. E. Ferdig (Ed.), *Handbook of research on effective electronic gaming in education* (Vol. 3, pp. 1104-1126). Hershey, PA: Idea Group. [3] Lunar Topographic Orthophotomap (LTO) Series – LTO-40B3 (1974). http://www.lpi.usra.edu/resources/mapcatalog/LTO/lto40b3_1/. [4] Ruberg, L. F., & Baro, J. A. (1999). BioBLAST: A multimedia learning environment to support student inquiry in the biological sciences. In W. C. Bozeman (Ed.), *Educational technology: Best practices from America's schools* (2nd ed., pp. 62-71). Eye on Education, Larchmont, NY.

Timocharis

Name	Dia (km)	Depth	Rim Ht	Wall Width	Floor width
Timocharis	33.0	3.0	0.85	8.0	15
Timocharis B	5.25	1.16	0.18	1.4	0

1: central peak
2: terraces
3: flat floor
4: rim crest
5: wall
6: glacis
7: impact melt pond
8: econdary crater chain
9: rille

Lunar Orbiter IV-121 image of Timocharis with features to be investigated in *MoonWorld*.