Learning to be Scientists via a Virtual Field Trip (Demonstration)

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ABSTRACT
We have developed the virtual world of Omosa in which school students can learn what scientists do by doing it themselves. In Omosa students are able to observe, collect data and interact with a number of intelligent virtual human and animal agents.

Categories and Subject Descriptors
I.2 ARTIFICIAL INTELLIGENCE; I.6 SIMULATION AND MODELING, I.6.3 [**Applications**] I.6.7 [**Simulation Support Systems**] *Environments*

General Terms
Design, Experimentation.

Keywords
Agents, artificial life, boids, educational virtual worlds, biology education, science inquiry.

1. INTRODUCTION
Genuine scientific inquiry is rare in the classroom. Reasons for this include the reluctance of teachers to engage in genuinely open-ended inquiry arising out of pressures to create efficient learning trajectories and cover all topics in a mandated curriculum. This difficulty is exacerbated by a science curriculum that has become theory and textbook heavy due to resource limitations and occupational health and safety (OH&S) issues. In particular, Zappala [6] notes that teaching behavioural ecology and ethology (the scientific study of animal behavior) is limited by physical, practical and ethical constraints such as: confounds and control of extraneous variables; observer bias leading to data tainting; difficulty of capturing rare events and behaviours; and infeasibility of large scale or long term study. Furthermore, while laboratory conditions can provide consistency and repeatability, for many species this approach may be undesirable or inappropriate"[i]. The ability to conduct a virtual field trip can address many of these issues and provide an opportunity for students to gain knowledge and skills needed for scientific inquiry such as hypothesis formation and testing, designing experiments, conducting investigations, using secondary resources and data, using equipment and ICT, managing risk, collecting data, performing analysis and drawing and communicating conclusions.

In addition to providing a hands-on and experiential approach to honing students' scientific inquiry skills, we are also interested in teaching students about complex systems such as ecosystems. Multiagent systems are particularly suitable for this purpose because while each individual agent may follow a small set of rules complex behaviours at the group level tend to emerge. To this end, we have developed the virtual world of Omosa in which school students are able to observe and interact with intelligent virtual human and animal agents.

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2. PROBLEM SCENARIO
In Omosa World the students, as junior scientists, are invited by the Chief Scientist at the IEIA (Interplanetary Environmental Investigation Agency) to assist in discovering why planet Omosa has been showing signs of ecosystem change. The indigenous people who live there have reported that the populations of certain species of animals, including those that are an important food source in their society, are declining. The Omosans have agreed to allow scientists to come and study the situation.

Students utilise workbooks to explore different issues and record their findings. Some activities occur in the world (e.g. speaking to the climatologist, hunter or ecologist agents and observing the animal agents); some in the classroom (e.g. proposing a hypothesis and describing the experiment to be conducted to the whole class). There is a progression in concept development as students move from one problem to another.

3. THE VIRTUAL WORLD TECHNOLOGY
Omosa has been developed using the multi-platform game development environment called Unity3D (unity3d.com/) that has inbuilt graphics and physics engines and features such as lightmapping and occlusion culling. To create the Omosan landscape itself and its base texture we used L3DT, a terrain generating tool (www.bundysoft.com/L3DT/). We then imported the heightmap into Unity3D and used its terrain editing tool to add the grass and trees. This tool makes it easy to place details onto a terrain and remove them if the size of the game becomes too large. The island of Omosa contains four main locations (village, hunting ground, weather laboratory, research station) where students can collect information and complete activities. We used Blender (www.blender.org/) to model structures and Mixamo (www.mixamo.com/) to create low polygon human models. We purchased our animals from TurboSquid (turbosquid.com/), where 3D artists can sell models. The models on TurboSquid usually have a high polygon count, which is especially undesirable when creating large herds of animals. We purchased four animals from the same artist, 3Drivers (www.turbosquid.com/Search/Artists/3DRivers). Three of the models are of extinct animals (Andrewsarchus, Bluebuck, and Indricotherium) and one is of an Iberian Lynx. Each had more than 6000 polygons. Using Blender we reduced the number of polygons to no more than 1800 each.

4. OUR AGENTS

The human and animal agents in Omosa are not directed or led by any other agent. However, the rules which drive them, particularly those relating to their predator and prey roles, result in numerous emergent group behaviours. Part of the behavior we wished to simulate in our animals was their tendency to live and move in flocks or herds and the emergent behavior that this demonstrates. To achieve this we started with an implementation of the Boids flocking algorithm [4]. Fundamentally the original Boids algorithm involves the summation of multiple vectors (separation, alignment and cohesion) to achieve a single output vector which determines the direction for each boid. These vectors represent the intentions of the boid. We rigged and animated our animals in Blender and imported them into Unity3D where we applied our modified Boid algorithm and Unity3D's physics engine. This presented another challenge, namely balancing the processing requirements of the modified Boid algorithm with the processing requirements of the graphics. We have solved this primarily by increasing the number of frames between each animal in the herd updating its behavior. This slightly decreases the realism of the animals' behavior but significantly improves game performance.

Other virtual worlds for scientific exploration exist, such as Quest Atlantis [1] and Virtual Singapura (VS) [2]. The intelligent predator-prey and flocking behaviours of our animals allows students to conduct observation as they might in the field (see Figure 1). This distinguishes our work significantly from other projects; changing the data gathering process from reading agent/avatar dialogues to experiential learning.

Figure 1. Tooru (predator) feeding on a Yernt (prey)

Figure 2. Hunter agent beckons user to come over

5. INTERACTING WITH OUR AGENTS

Students are able to interact with our agents in a number of ways. Firstly, as the user approaches, the agent will wave (see Figure 2). If the user walks up the agent, they are able to click on the speech bubble (as shown on the waving hunter) to initiate a dialogue with agent. Dialogue is basic and allows the user to select questions they wish to ask the agent. Questions are ordered/included based on the prior activities and demonstrated knowledge of the student. Additionally, users can select/collect data and items and observe the Omosans and animals in their natural settings. Students are able to perform laboratory-based prey-predator simulations using NetLogo [5]. However, to assist with development and balancing of our ecosystems involving the 3D animal agents, numerous parameters can be adjusted (see Figure 3). Interactions between animal agents are described in our full paper in this proceedings.

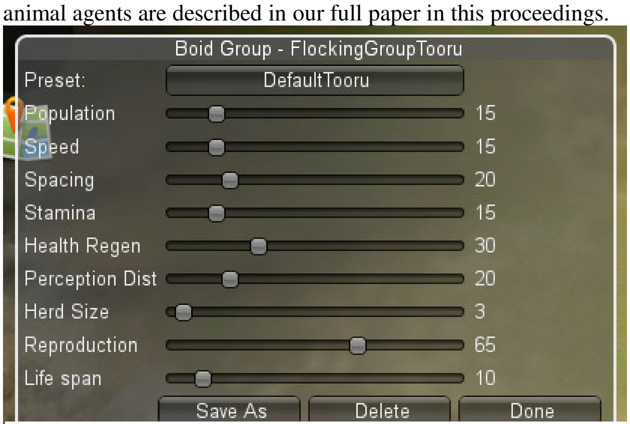

Figure 3. Predator-Prey Agent Parameters .

6. EVALUATION & FUTURE WORK

To ensure the accuracy of the behaviours of our animals in Omosa we 1) based our animal agents on Wilensky's Wolf Sheep Predation model [5] 2) included biologists on our team and 3) had an independent animal communication and conservation expert evaluate and tweak our animal behaviours. To design and evaluate Omosa as a learning environment we consulted biologists and secondary science teachers, performed an initial pilot with an afterschool science special interest group and used our world and workbooks over a two week period in late 2011 with around 50 Year 9 children in two classes (one comprehensive and one selective) involving four 50 minute lessons for each class.

In 2012 we will be adding new scenarios and schools. From an educational research standpoint we are conducting classroom based experiments on the merits of *productive failure* [3]. From an agent standpoint, we will focus on collaborative learning involving agent-human and human-human collaboration. A demonstration of Omosa can be found at http://www.comp.mq.edu.au/~richards/aamas12Omosa/

7. REFERENCES

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