

# Online Map Games – playful interaction with complex real-world issues

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## Abstract

We present our work with GeoGames that are played on top of online geographic maps, using the real world as the game world. The developed technology represents an innovative potential for geographic inquiry-based, learning through play, which through the internet can reach a massive audience. The described "Green Revolution" game is meant to teach students about the challenges of farming in developing countries. The major part of the paper describes a web GIS architecture in which the game is implemented. Participants play the game and engage in an open discussion around the game. Some results from user testing, and its potential for further use in cyber-learning research are presented.

*Keywords:* Online games, GIS, geographic education, cyberlearning

## 1 Introduction

Maps of different types have often played an important role in recreational and educational games: treasure maps in board games, schematic reality-inspired maps in Monopoly, schoolyard replicas of continents and the world, and so on.

Advancements in Internet-based GIS now provide much more analytical functionality than simply looking at a map [1]. Web 2.0 GIS and mapping platforms provide easy access to massive volumes of data through geospatial data portals, mapping of real-time data, the ability to create and share your own data [2], and an emerging Geospatial Web [3] with opportunities for people to 'hang out' through spatially enabled online social networking.

Similar to gaming technologies, digital online geographic mapping platforms have tremendous potential as platforms for cyberlearning, allowing for interaction with vast new flows of scientific data, simulation, visualization, spatial thinking and social knowledge construction on the web [4]. Important is also that these technologies have recently become freely available and practically operational in a web environment that also allows learning to happen anywhere at any time.

## 2 Previous and ongoing work

Our team recently outlined Online Map Games (OMG!), or GeoGaming, as a potential platform for anything from simple, amusing trivia games for casual use to structured educational exercises [5, 6]. Our proposed platform integrates the use of online Geographic Information Systems (GIS) and Massive Multiplayer Online Gaming (MMOG) technology as a novel approach to environmental modeling and simulation, and as a platform for educational games. Our proposed GIS-MMOG

platform represents an innovative framework for spatial inquiry-based, play-like learning that through the internet can reach a massive audience.

Continuing our previous line of work, and as part of an ongoing NSF-funded project, we have developed a web browser-based, multiplayer, educational game called GeoGame Green Revolution. The learning scenario for our current prototype is to teach the complex, real-world concept of the Green Revolution to Geography students. Between the 1940s and late 1970s, the Green Revolution stimulated increased agricultural production in many countries. This movement, led by the "Father of the Green Revolution", Norman Borlaug, applied many new technologies and research to agriculture. Some main innovations that drove the Green Revolution were the development of high-yield seeds, use of artificial fertilizers and pesticides, and the improvement of irrigation systems [e.g. 7]. GeoGame Green Revolution was developed with a purpose of giving students an on-the-ground perspective of farming in developing countries, and our game is adapted from a group activity on the "Green Revolution" published by Engineers without borders Canada [8].

The primary learning goal of the *Green Revolution GeoGame* is to give students a better understanding about the challenges of farming in developing countries. Specifically:

- Students will describe a number of specific interrelated factors that are involved in success/failure of small farm owners, some of which are related to green revolution technology.
- Students will recognize and explain that while the technology introduced by the green revolution can be helpful, achieving success for small farm owners can be very difficult, and in some cases impossible.

As part of the design and research process, we have integrated the game into an undergraduate introductory Geography

course as a homework assignment. So far our testing has gone through four semester iterations, from Fall 2012 to Spring 2014 with a total of 600 students successfully completing the assignment.

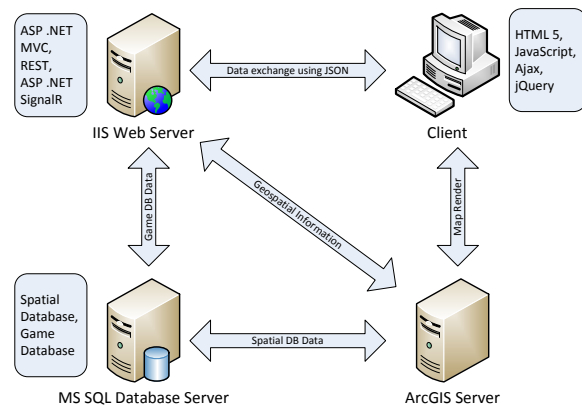
After the signup process, students choose a family and start farming on digital plots of land located in India. Each turn represents a single growing season, and during each turn students must decide how to manage their land and resources: irrigate and fertilize plots of land to varying levels, plant land race or high-yield seeds on each plot, buy and sell their yield at the market, buy more parcels of land, purchase an oxen to increase productivity, and purchase or sell additional labour. The number and length of the turns can be adjusted to fit a particular class schedule. The goal of the game is not a typical win or lose, but rather one of improving your abilities to manage the farm. Thus, it in many ways is more akin to a simulation of farming in the context of modernization of agriculture in developing countries.

### 3 Technological innovation

The current GeoGame prototype system is developed as a web application, delivered to users through a web browser. The web application is therefore easily disseminated, overcoming some of the hardware and software barriers that otherwise would restrict access for many K-12 students, schools, and the broader population.

The architecture of the GeoGame software is driven by the need to provide a *configurable* platform for supporting the research goals of GeoGame. To begin with, the software architecture consists of a lightweight web platform that merges multiplayer online gaming technology with online geographic information systems (GIS) technology, to allow players to experiment and interact with the geospatial data. The map is a very important part -- if not the most important part -- of our GeoGame idea. Since generic map services, like Google Maps, Bing Maps, OpenStreetMap, etc. are more or less zoomable static maps with a relatively low degree of customizability, and we want to access and manipulate all kinds of data, we use ArcGIS Server technology to provide map web services and a web interface for GIS geoprocessing capabilities. The web application is therefore easily disseminated, and it also helps to maintain and update the game so that small fixes, performance improvements, and other changes can all be released to the users as soon as they are finished and tested.

Figure 1: Servers and their interactions.

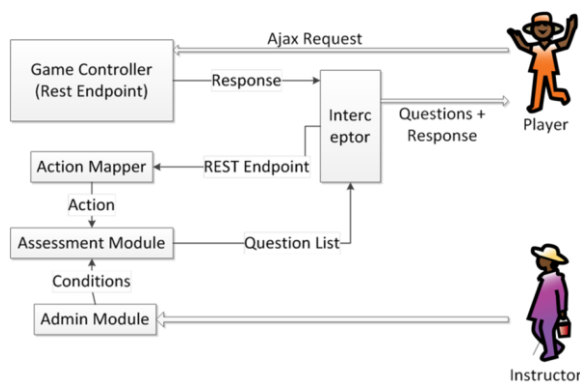


There are three different servers that communicate with each other and with the client machine: a web server, an ArcGIS server, and a database server. The client machine sends a request for a game specific map to the ArcGIS server. The ArcGIS server then fetches farmland details from the database server and renders a map on the client machine. To perform a game-specific action, the client machine sends a request to the web server. If the web server requires geospatial information to service that request, it communicates with the ArcGIS server. After servicing the request, the web server reports any changes made to the database server. Since GeoGame uses a stateless architecture (REST), every request is considered to be separate. Additionally, server side push technology also allows the server to push contents to a client without the client sending a request to the server which simplifies the process of achieving real-time user interaction. Server side push is implemented in GeoGame using ASP .NET SignalR technology.

To facilitate in-game studies of student learning, a separate but integrated assessment system has been developed to provide a flexible and easily configurable system. During game play the assessment module *intercepts* user actions to provide various prompts in order to gauge user understanding of the concepts embedded in the game. The game engine and the assessment module integrate the WebRule rules engine (<http://rule.codeeffects.com/>) for game rules in combination with .NET interceptors for pushing event-driven assessment questions. These components allow us to easily configure and re-configure the events and conditions on which the assessment questions are presented to the players, as well as the questions themselves.

We have also developed configurable technical components for implementing features aimed at increasing affective engagement within GeoGame, such as avatars and naming of family members (to increase identification of the player with the family in the game). These features are being tested.

Figure 2: Assessment system.



#### 4 Assessment of learning and promoting learning

The development process includes iterations which involved observing and interviewing students as to their thoughts about the game in general and the kinds of green-revolution specific concepts they learned. From this (combined with results from interviews with course instructors on instructional goals) came improvements on the game design as well as more finely tuned questions to pose to the students for the classroom implementation. Most of these assessment questions have been given between rounds but some have been given in response to certain actions, such as purchasing land race seed. Some example questions were:

- In your opinion, which kind of seed is better to plant, high-yield or land race? Briefly explain why.
- Farming in developing countries is hard work, but farmers can still have some measure of success. Agree or disagree?
- In your opinion, which is the most important item to spend money on, irrigation, fertilizer or high-yield seed (or some combination)? Briefly explain why.
- Did your definition or expectations of success for this game change during the course of the game? Briefly explain.

So far, our results show evidence of a positive learning outcome in that many students left the game with a better appreciation of the difficulties involved in the life of a farmer in a developing country, as well as some of the strategies needed to be successful (Mikula et al. 2013). This shift in student appreciation of the difficulties of farming in a developing country is aligned with instructional goals. However, it was also clear that the simplicity of the game (i.e. small number of variables) did not afford a deep and rich understanding of some of the important complexities of the green revolution. As such, the Green Revolution GeoGame is a useful tool to use as a course assignment in order to achieve some of the instructional goals stated previously, but clearly more work is needed to facilitate deeper reasoning and critical geo-spatial understanding.

Nonetheless, our collected data provides a resource for identifying particular affordances of the GeoGame environment that can contribute to this learning. Some

examples of such clues are shown in these responses when asked if their definition of “success” for farming in developing countries had changed over the course of game play:

“Yes because I wasn’t expecting some of the wild cards [that threw] off my projections.”

“Yes right in the very beginning my expectations for success went down after I was hit with a pest attack.”

#### 5 Future work

By now we have a well-tested technology platform and a “model-game” where we can start to iterate through refinements of the game. To allow for direct comparison between different versions of the game we have started to implement A-B testing by setting up parallel tests of the game and compare the types of thinking and learning gains that happen in slightly different versions.

With our established technology platform, we are currently focusing our attention to investigate the idea of a GeoGame as a micro-experience in the sense of experiential learning [9], and what is required of a GeoGame to provide mini-experiences through a cycle of concrete experience, reflection, conceptualization, and active experimentation. In addition, we also plan to separate how spatial factors (proximity to water resources, varying soil quality, varying country) are considered by the users and how they might affect the achievement of learning objectives. The ArcGIS environment will provide the necessary geoprocessing capabilities to serve the game with information about how for example one farmer’s decision to irrigate or fertilize their fields will affect access to water, soil quality and other geographical variables.

Together with instructors we have identified additional aspects as important to fulfill the stated Green Revolution learning goals:

- Adding new regions to help students compare and contrast issues in different areas.
- Adding different social circles and types of farmers in order to more accurately reflect the local social landscape.
- Variability in the ownership of the land, with some farmers owning their land and others leasing it (sharecropping)
- The existence of cooperatives and the effects of competition between them
- Adding consideration of socioeconomic and policy dynamics
- Increasing affective engagement within the game through personalization and virtual incentives.

In order to understand enough about what a GeoGame can offer as a learning tool it is important to continue working closely with learners, instructors, designers and learning experts to identify which places or events in a game that align with specific learning objectives in an assignment and how to tie those learning goals to incentives in the game.

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