Building Worlds and Learning Astronomy on Facebook

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Abstract: The Space Science Institute is developing *Starchitect*, a stellar and planetary evolution game for Facebook. Supported by NSF and NASA, the game uses the “sporadic play” model of games such as Farmville, where players may only take actions a few times a day, but may continue playing for months. This framework is an excellent fit for teaching about the evolution of stars and planets: systems evolve in scaled real time (a million years to the minute), so that massive stars supernova within minutes, while stars like our sun live for weeks, possibly evolving life before ending their lives as white dwarfs. Simultaneously, however, the framework raises a variety of challenges relating to depth and breadth of content, conflicts between known science and gameplay, and evaluating long duration activities with finite resources. We will examine some of the challenges (and opportunities) we have encountered to date.

Starchitect

With support from NASA (NNX11AI26G) and NSF (DRL-1010624), the Space Science Institute is developing an end-to-end stellar and planetary evolution game called *Starchitect* for the Facebook platform, with external access for middle school students. We have focused specifically on the “sporadic play” approach popularized on Facebook (early examples included *Farmville* and *Mousehunt*). A defining characteristic of these games is the deliberate limiting of gameplay for a single sitting. In the case of *Farmville*, crops are planted and the player must wait a day or more to harvest them. In *Mousehunt*, players can only attempt to catch a mouse every 15 minutes. Game actions also tend to be simplified, which serves to keep the game low key and inviting. Simultaneously, the game is structured so that the player benefits by returning regularly. Unattended games will either stop progressing or, in the case of *Farmville*, crops may wither and die. This strategy appears to simultaneously attract players who are only seeking occasional distractions, while encouraging ongoing play. We find this model particularly interesting in an education context, where it creates an opportunity to reinforce the game’s content and message.

In addition to this framework being of general interest for educational games, it is an excellent fit for this particular context of teaching about the evolution of stars and planets since, like the plants in *Farmville*, the systems evolve over time. Players select regions of the galaxy to build in, then watch as the systems evolve in scaled real time over days to weeks. Massive stars supernova within minutes, while lower mass stars like our sun live for weeks, possibly evolving life before passing through a red giant stage and ending their lives as white dwarfs. Successful systems advance players, allowing them to create different types of stars and planets, seed life, and customize their worlds. As players progress in the game they explore concepts that include stellar lifecycles, habitable zones, and the roles of giant worlds in creating habitable solar systems.

Game Elements and Learning Goals

Starchitect runs persistently in the background so that systems continue to evolve while the player is offline, extending game play to weeks or more. The time scale for the game is one million years per minute (for reference, that would make our own solar system a little over three days old). This approach allows us to introduce the relative time scales of a variety of events relevant to solar system evolution: giant worlds can be built in a few minutes, terrestrial worlds a few minutes after that. Single cell life can arise within an hour, but complex life can require several hours. Star lifetimes can range from seconds (for super-giants) to weeks (for sun-like stars).

Game flow is controlled through a combination of energy (which is consumed to create worlds, but replenishes over time) and locks, which lock out features until certain conditions are met. The game encourages specific actions through “Feats;” accomplishing each Feat earns badges and titles and unlocks more features (for instance, moons).

The structure of the game lets us directly address a number of key astronomical concepts, including that stars differ from each other in size, temperature, and age; stars have a life cycle: they are born, age, and die. These life cycles depend on the star’s initial mass and have dramatically different lengths and outcomes; giant worlds have significant effects on the structure and habitability of a solar system; and “habitable zones” influence the habitability of terrestrial worlds, varying with the star type.

In addition, the Feats system lets us target individual tasks that might have educational value: for instance, we can challenge the player to recreate our solar system, or to place a terrestrial world in the habitable zone of a red dwarf star.

Finally, several mini-games are included that allow us to include content that might not be well addressed in the main game framework or that enable us to target specific misconceptions. One example of this is *Sizemology*, a mini-game that compares the sizes of different objects (Earth compared to the sun, the sun compared to an astronomical unit, etc.) It was clear from the start that players would want to view their systems with the exaggerated scales typical of solar system illustrations, but we wished to avoid reinforcing misconceptions about solar system scales. The compromise solution was to build in the ability to “fake” the scale sizes of objects in the solar system but to lock that feature until players successfully explore the minigame. *Sizemology* therefore serves both to address a set of “size and scale” learning goals and to provide the unlock mechanism that allows players to alter the scale of their own systems.

Progress, Early Results, and Next Steps

Starchitect is currently open to play both on Facebook (search for “starchitectgame”), as well as externally through www.starchitect.net. The non-Facebook access was designed specifically to make the game available to middle school students; however, the feature has proved useful even at the university level, where the game has been used as an extra credit assignment for introductory astronomy classes. This is aided by a “group” feature that allows students to see each other’s progress.

Formative evaluation was performed iteratively, recruiting adult players and observing play using screen sharing. We can also examine in-game data to determine how players are using the game, analyzing how much time players spend in the game and over what period. Early assessment of this data suggests that we are meeting our goals with respect to the sporadic play, frequent return model. We define “elapsed time” as the time between first and last touch of the game (independent of how much they played), and a “session” as a 30 minute or less encounter with the game (independent of the time over which those sessions occurred). Of players who returned at least once, the medium elapsed time is approximately 12 days. However, the distribution has an extremely long tail: 20% of the players had an elapsed time of greater than 30 days, and 10% greater than 90 days. Similarly, the median number of game sessions is only 4, but 20% returned 22 times, and 10% over 50 times. Note that these values are strongly skewed by the fact that the game has only been broadly available for six months or so.

Processing of in-game data has also provided us with a number of other preliminary results: By comparing in-game quiz results to existing surveys, it appears that the population playing the game is more science literate than average. This includes astronomy as well as non-astronomy related content (for instance, the percent of correct answers to “Antibiotics kill viruses as well as bacteria, true or false” is 14% higher for the game population). Facebook players are much more likely to return to the game for a second day than non-Facebook players (35% versus 13%). This isn’t particularly surprising, since one of the advantages of the Facebook platform is to make long-term games easier to access. Pre/Post assessments (also implemented through the in-game quiz) suggest at least marginal improvements in content knowledge, ranging from gains of a few percentage points to 15 percentage points (though there is one apparent example of a negative gain). However, the number of data points is still small, with N ranging from 12 to several hundred, depending on the question.

Over the next six months we will be focusing on increasing the number of players and tuning the game, while the summative evaluation examines in depth the degree to which we have met our goals for the project. Summative will consist of a combination of data collected in-game as well as interviews with selected players who opt into the evaluation. This should allow us to determine not just if the game succeeds in teaching players more about astronomy but whether the “sporadic play” design holds potential for other education efforts.