TreeBit: A smartphone game with "evolving" pixel art to teach about life through time

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Abstract: *TreeBit* is a smartphone game designed to teach young adults about the framework central to all biology; the phylogenetic Tree of Life that shows how all species on Earth are related to one another. Evolution is central to *TreeBit* and, thus, to the game's design. Game art "evolves" from level to level with pixel art of increasing complexity. *TreeBit* has two components, 1) a Tree World framework that showcases the amazing diversity of life and shows the relationships among species and 2) game levels in which a player learns about important events in the history of life and unlocks sections of the Tree World. Each game level has different winning scenarios that unlock different portions of the Tree World, encouraging levels to be re-played for different outcomes. Here, we introduce *TreeBit's* concept and learning goals, and detail our early design decisions.

Introduction

One of the grand topics in biology is the detailed pattern of relatedness among life forms, reflecting the process of diversification which formed the evolutionary Tree of Life. These evolutionary trees, as seen in ToLWeb (tolweb.org), are the central framework for a wide range of biological disciplines ranging from medicine and pharmaceuticals to ecology and evolution. However, for the majority of people, the Tree of Life remains largely unknown. Here, we introduce *TreeBit*, a smartphone game designed to engage young adults with the Tree of Life through a combination of game levels and a framing game world. *TreeBit* blends an innovative art style, current scientific research, and progressive game mechanics in an educational game for mobile devices.

Visualizations and games to explain the Tree of Life are a hot topic and many projects are underway. Two projects are leading the visualization of large trees: *deeptree* (Block et al, 2012) and *OneZoom* (Rosindell and Harmon, 2012), which are focused on simplifying tree visualization and are not games. Other groups are developing games with explicit learning goals about the Tree of Life e.g., Harvard and Northwestern's *Build-a-Tree* and *FloTree* (see Perry, 2012 for a summary). *TreeBit* fills a niche by targeting a young adult audience, deploying on mobile devices, and tackling both tree visualization and gameplay at important points within the history of life.

The Game

TreeBit is a pixel-art smartphone game developed with the Unity 3D game engine. Currently in alpha testing on Android devices, *TreeBit* targets young adults ages 16-30. *TreeBit* is based in an evolutionary Tree World where players can explore the diversity of life by swiping and tapping on branches and nodes. To explore fully, players must unlock sections of the Tree by playing game levels. The levels use a simple input to gamify important branching moments in the Tree of Life. Because these game levels take place at particular moments in the history of life, they are tied to specific points in Earth's history (geologic periods). For example, to open the Tree World players must first complete a game in the Precambrian Period of Earth's history. The player controls three single-celled eukaryotes and must collect mitochondria and/or chloroplasts, avoid viruses, and get to the reproduction zone to win. Depending on which type of organelle the player collects (more mitochondria or more chloroplasts), either the plant half of the Tree World or the animal+fungi half of the Tree World unlocks.

Learning Goals

The development of *TreeBit* is centered around learning goals that include but are not limited to: 1) understand that life is diverse, 2) understand how species are related in a phylogenetic tree, 3) understand that the trunk and branches of the Tree represent an axis of time, 4) understand how certain abiotic (climate) and biotic (predation) factors affect speciation or extinction, and 5) understand that speciation and extinction can alter or create the structure of the Tree of Life.

Design Decisions

The history of life is a series of important events that led to the formation of new species (branching points) or the extinction of species (end of a lineage). Thus, many events could be included in *TreeBit* and the use of these seminal moments gives us the ability to expand the game almost infinitely. The variety of possible events posed a significant design challenge. With all of these options, where should we start? Initially, we chose to focus on better-known seminal moments such as: organelles and the evolution of single-celled Eukaryotes in the Precambrian Period, the evolution of jawed fishes during the Silurian Period, the evolution of flight in early birds/dinosaurs in the Jurassic Period, pollination and the diversification of flowers in the Cretaceous Period, and the evolution of leg length in horses during the Miocene Epoch. These examples appear in most text books and popular science literature, increasing the chances that our audience would have at least a passing familiarity with them.

Game Art

Another important design challenge was how to best represent the Tree World and game levels in an engaging way that aligned with our learning goals. We chose a pixel art style because of its popularity with our target audience. To promote the understanding that life changes over time, we elected to make the pixel art change as a player progressed through the Tree of Life (and thus through time). We selected eight major pixel art styles and mapped them to the geologic time scale. For example, a game level that takes place in the Precambrian Period (540 million-4 billion years ago) is styled after Atari games of the early 1980's, whereas a game level that takes place in the Jurassic Period (154-206 million years ago) is styled after Super Nintendo games of the 1990's. To our knowledge, utilizing an "evolving pixel art" style is novel. More importantly, this style draws upon the popularity of "retro" games and reinforces the idea that the Tree of Life represents an axis through time.

A Unifying Game Mechanic

Because *TreeBit* represents a great diversity of life through time (essentially different "characters" in every game level) and utilizes an evolving art style, we chose to unify the game through the game mechanic. But what smartphone game mechanic would apply equally well to groups as diverse as single-celled organisms and dinosaurs? And what type of mechanic could stand on its own and be a true game and engage and challenge the average player? We decided to start close to the base of the Tree of Life with a game level that focused on organelles and early eukaryote cells (described above). We developed a game mechanic that was based on a single input (swipe) controlling multiple players within the level. Then we tested that mechanic on a level involving more complex organisms, movements, and graphics (birds/dinosaurs in the Jurassic Period). Two factors influenced our choice of the second test level: 1) the immense popularity of dinosaurs and 2) the timing of that event (in the Jurassic Period) would require very different graphics from our evolving pixel art style. Through iterative development with feedback from limited focus groups with our target audience, we are finding that the unifying game mechanic is successful for these two vastly different times and organisms and is perceived as fun and addictive. As we build the next iteration of *TreeBit* we will test the mechanic and its appropriateness for our audience, assess if the game's learning goals are being achieved, and examine if we are engaging players in Tree of Life concepts.

References

Block, F., Horn, M., Phillips, B.C., Diamond, J., Evans, M., and Shen, C. (2012): The DeepTree Exhibit: Visualizing the Tree of Life to Facilitate Informal Learning. IEEE Transactions on Visualization and Computer Graphics (TVCG)

Perry, C. (2012): Teaching tree thinking through touch. Harvard University press release. http://www.seas.harvard.edu/news-events/press-releases/teaching-tree-thinking-through-touch retrieved on 1.29.2013.

Rosindell J., Harmon L.J. (2012) OneZoom: A Fractal Explorer for the Tree of Life. PLoS Biol 10(10): e1001406. doi:10.1371/journal.pbio.1001406