

A Gamified Approach to Academic Learning in a High School Biology Curriculum

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Abstract

Within the field of education there has been a significant push towards a more game-centric approach to learning. For this study, this author worked with the biology department of Farmington High School based in Farmington, Connecticut with the purpose of constructing and analysing the efficacy of a game-based curriculum. This goal was approached by developing a lesson plan and attaching a divergent, arching narrative to each topic covered. It was met with varying degrees of success amongst the student body as some found it helpful while others found it a nuisance, opting to skip past these sections of the assignments. It is hoped that this study will assist educators in developing a successful model for a gamified curriculum.

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1 Introduction

Since the dawn of recorded history, games have played an integral role in a multitude of respects. The key facet of games has primarily been entertainment, but for many cultures games have also functioned as a diplomatic facilitator, a source of revenue, and even as team-building exercises. At their core though, games exist as a social lubricant to bring people together, requiring them to operate within a shared set of rules. They intrinsically emphasize fairness between all parties involved and promote a sense of trust as the players are all expected to play by the same rules.

This social component intrinsic to the vast majority of games has established them as a staple of interpersonal problem-solving. The ancient Romans used games to keep the common people subdued despite living under a government plagued by corruption; people were far less likely to revolt if their government supplied ample entertainment. The ancient kingdom of Lydia, as recorded by Herodotus, used dice games as a means of rationing food-stores. During a period of significant drought, it was clear that if something was not done, the people of Lydia would starve. The government at the time introduced a new ruling that declared that half the population would fast and play games one day, while the other half would eat. This effectively doubled their supply of food until the drought had passed, all of which was possible by diverting the attention of the public so that they were not focused on their hunger (Herodotus, 20). Even now, in the present day United States, many of our leaders turn our attentions to our sports teams as a means of distraction from the woes of the age.

This is not inherently negative, however; games are designed to distract. Players forget that they are engaging in a learning exercise so long as the predominant feature is the gameplay. This is why serious games have flourished alongside those that are explicitly made for the purposes of entertainment. This idea also forms the basis for the thesis of this paper.

1.1 Serious Games

Serious games are games made with an underlying purpose in mind. This purpose is usually to propagate some idea or concept that the authors believe is of great importance. Though the style of serious games may vary significantly, the purpose of serious games always is to inform or instruct players about

- Public awareness issues
- Evolving social views
- Current causes or movements

Perhaps the most well known example of a serious game is the *America's Army* series. It is one of a number of games owned by the United States Army and released as a free-to-play game to the public. The original iteration was developed by Colonel Casey Wardynski and released in 2002 (McLeroy, 2002) as a success among critics. It was named the *Editor's Choice Award* by the *Computer Gaming World* magazine and *Best Use of Tax Dollars* by the *Computer Games Magazine* in 2002. The developer of

America's Army understood that for his message to get across, the game would have to be, first and foremost, entertaining.

But the entertaining elements of this game were not the focus, nor the primary reason for making it. Wardynski designed and developed this game as a way to approach people who play games and to highlight the goals and lifestyles of the army. The game currently has over five and a half million users registered through the *America's Army* website, nearly half of whom have advanced from basic training to more specialized programs (Allen, 2017). Although the United States Army has not provided any data, it would be interesting to know whether *America's Army* has been an effective recruitment tool. Based on the fact that more than twenty updates were made to the game from 2002 to 2016, it can be inferred that it was and is still considered a successful game.

Furthermore, the success of this serious game can be measured in its training applications. There is a long and storied history within the United States military of using games as a means of preparing soldiers for combat. In fact, what's considered the first video game ever made, *Spacewar!*, developed by several Massachusetts Institute of Technology students, was funded by the Pentagon (Mead, 2013). This game may not have had any direct uses as a training exercise for troops, but it did lead to the standard of game-based controls and monitor visuals that would be used in all subsequent training simulations.

These early games funded by the military spawned a number of projects that continue today. Recently, there has been a push to prepare soldiers on all fronts not

just combat. Games such as *UrbanSim* and *Tactical Iraqi* were created with the intent of provisioning soldiers for the cultural climate of the countries they would be deployed to (Shaban, 2013). These games emphasized intelligence gathering in a foreign land and proper interactions with the local populations.

These types of games also were quite attractive to the Army's higher-ups because they could be adapted to situations that were extremely different. They were not limited to a single scenario, whether cultural norms or mission-related readiness. Serious Games could be adapted to meet the needs of any given training scenario. By adjusting the mission briefing section of *America's Army*, troops about to be deployed to Yemen could be taught the cultural norms and political structures of the Yemeni. This offered a distinct advantage to the United States military in areas where conflict was limited to guerilla tactics. Because the army was not fighting a clearly demarcated enemy, it was especially important to gain the trust and support of local residents in determining who exactly was the enemy.

The introduction of simulation-based learning and modifiable pedagogical scenarios has led to a paradigm shift within the education community. Leading educators are exploring gamified curricula to determine whether it could support classroom instruction. Since many students find electronic media more engaging and attention-keeping than traditional learning formats and find the learning format more suited to their learning style, many educators feel that in the future Serious Games will be an indispensable component in educating students.

It is the belief of some educators, as well as that of the author of this paper, that incorporating gamified learning with traditional learning formats (e.g., textbooks, student research and writing, direct instruction) will provide students with a richer learning environment and more opportunity to explore different aspects of topics than previously. The thought is that if students are immersed in a game that explores a subject they are familiar with, the activities in the game would deepen their understanding of that subject.

1.2 The Moral Debate Surrounding Serious Games

For many, using games as a means to inform the public on a subject is a frightening concept. The complaints surround the principle of potentially indoctrinating younger audiences into the developer's way of thinking. Is it ethical to market a free-to-play game to people ages fourteen and older with the underlying intent of recruitment into the military? Many vehemently oppose this idea, but the United States military has been very upfront about the security and privacy of its user base. They have zero avenues of direct communication with the people that play *America's Army* and do not save their contact information (McLeroy, 2002).

But that still raises the question of where a developer must draw the line when drafting a game with the express purpose of pushing an agenda. Should governments step in and regulate the type of information that should be provided to younger audiences? Could this apply also to adult audiences? This was relevant when

designing and developing an educational game for a high school biology curriculum and resulted in additional design time to ensure that content in the game was balanced.

1.3 Serious Games In Education (Related Work)

A number of studies have been produced in reference to the efficacy of gamified curricula with widely varying results. One such study, *Serious Games in Education* (Stege et al, 2011), found a clear link to a student's measure of success on assignments depending on whether they had been taught the material through games or a more standard approach such as a lecture. In this study, two groups of students were taught about some of the more basic concepts surrounding electrical engineering theory. The first group was given access to the game *E and Eve's Electrical Endeavors* while the control group was given a textbook with the exact same information as in the game.

The experimental group's game revolved around assisting the main character in escaping a tangled mess of electrical wires. The player is taught how to "resolve problems with resistances, transistors, and power shares" (Stege et al., 2011, p. 3) so that the character can move to the next area and escape the electrical prison.



Figure 1. *E and Eve's Electrical Endeavors*

In this image, the player must adjust the voltage of the conductor to allow the character to pass harmlessly through the circuit. By progressing through each level, the player is incrementally taught the precepts of Ohm's Law. In contrast, the control group was given a textbook outlining the same principles and instructed to read through the selected chapters until they felt comfortable with the content. The researchers made sure to have a healthy proportion of students interested in science in each group, offset by those who were not. This was determined based upon each student's grades in previous science courses. Once each group had finished their reviewing on the information, they were tested on comprehension.

Based on the results, a stronger relationship was established between the experimental group and successful comprehension of Ohm's Law. This was found by

comparing the average test scores of the two groups. The group exposed to the game averaged 3.31 on the test, while the group given the text averaged only 2.96 (out of six). That being said, the authors of this study also analyzed the comprehension rate of just the female participants and discovered that the experimental group performed significantly worse than the control group. The game-group scored 2.82 on the test, while the text-group scored 3.12 (out of six).

Through a question-based survey, the authors determined that this may have been due to the discrepancy of female participants' exposure to games, as compared to that of male participants. The scores of female participants suggests that the scores of males exposed to the game on average exceeded 3.31 while those who were not averaged below 2.96.

This also suggests that the design of the game may have been more aligned with types of video games normally played by males. The researchers found that male participants performed at a higher level of comprehension and were more open to approaching learning through games. Female participants were less versed in video games as a medium and, consequently learned less well via games than through a more traditional format. These differences need to be considered in game design to ensure that female and male players will benefit equally from Serious Games.

1.3.1 Gamified Classroom Environments (Related Work)

Alternatively, many researchers posit that it is not as simple as breaking down core game design principles and applying them directly to the classroom with means of a video game. For example, Elizabeth Lane Lawley and Adrienne Decker, two professors at the Rochester Institute of Technology, explored the process of developing an “achievement system” within their first-year undergraduate classrooms. In their thesis, *Life’s a Game and the Game of Life: How Making a Game Out of it Can Change Student Behavior*, these two authors delve into the successes and failures of their *Just Press Play* project.

These authors had noticed a worrying trend among students, in which they felt ostracized by the complexity and difficulty of many scientific disciplines. In many cases first-year undergraduate students tended to feel out of place in these environments and would often give up before giving the subject matter any real effort. To this end, instead of creating a physical game to teach concepts, these educators devised a classroom environment that was more inviting to students new to the field. *Just Press Play* is based around the principle of an “achievement system” (Decker et al, 2013, p. 233) that rewarded a student for accomplishments made within the structure of the course material. From this, the authors devised the “gaming layer” (p. 233) which encompassed all portions of the classroom that essentially involved a scoring system. The goal was to motivate the first-year students to be more proactive and collaborative in their work. The authors accomplished this by incorporating a game-based scoring

and achievement system for the purposes of emphasizing satisfaction in success and mitigating feelings of hopelessness in failure.

One of the facets of this project that the authors credited to its success was its promotion of student interaction. Students, both upper and lower classmen, received achievement rewards for engaging in collaborative events. At these sessions, struggling students could interact directly with peers who had a stronger grasp of the concepts incorporated in the assignments and use their expertise to better their own understanding. It also offers an environment where there is less perceived risk of appearing ill-prepared for the rigors of the course material. A student may feel uncomfortable about approaching a professor with their knowledge gaps, but with peer-to-peer collaboration this anxiety is significantly less pronounced.

1.4 The Multiplayer Classroom (Related Work)

Perhaps the most influential work towards this author's thesis was the work of Worcester Polytechnic Institute's own Professor Lee Sheldon. In his book *The Multiplayer Classroom* he approaches the classroom much in the same way that Elizabeth Lane Lawley and Adrienne Decker approached theirs with *Just Press Play*, but with considerably more depth in its application. Where *Just Press Play* focused mostly on incentivizing student involvement in the course's curriculum via a reward system, *The Multiplayer Classroom* structures the learning in the same way a game developer designs a video game. To this end, there are a number of design principles

that should be defined for the purposes of setting up the methods that will be employed for the research portion of this thesis.

1.4.1 Grading System

For starters, in the eyes of Sheldon, the students' grades should start at the same conceptual place as their understanding of the topics being covered. Since they are there to learn, the starting grade should be a zero; they are expected to work up towards their final grade rather than chipping away at a perfect mark. So, a core concept of *The Multiplayer Classroom* is that the students work from the ground up for their overall grade rather than from the ceiling down.

To work from the ground up leads into the next concept illustrated in this book: its curriculum structure. Sheldon provides the students with a framework for how they are to pull themselves out of their failing grade and into a passing one. This is done by creating a video game environment in the classroom much akin to the environments seen in the massively-multiplayer online role-playing games, or MMORPGs for short. In these MMORPGs, players create avatars which do their bidding and are their stand-ins in the game. These avatars start off at the lowest level possible, level one, and from there complete quests, battle opponents, and explore the world to earn enough experience to level up. Experience is the in-game currency of leveling mechanics. To level up, a player must reach a given threshold of numerical experience. Set values of

experience are awarded to players based on the activities they are successful in accomplishing. Leveling up thus gives the player a clearly demarcated progression. Their character started off weak but, through completion of training exercises, were able to attain a greater power.

This is used in *The Multiplayer Classroom* as a means for students to view themselves as players within the subject matter assignments and their grade as the effective “level” of their character. To create an immersive environment for the students within this multiplayer classroom, Sheldon renamed the standard conventions of a course syllabus to better reflect an MMORP game-world. Quizzes and exams would now be deemed “defeating monsters” (Sheldon, 2012, p. 26), papers are considered “crafting” (Sheldon, p. 26), and all presentations on reading assignments were regarded as “quests” (Sheldon, p. 26).

For reference, many MMORPGs incorporate what is called a crafting system into the game mechanics. Crafting is the act of gaining raw materials from the world and then turning them into finished goods. These finished goods can then be used by the player, his or her allies, or sold on the in-game market for profit.



Figure 2. Pixel Boy.

This image displays the crafting system of the game *Pixel Boy*. In this menu, players are able to turn the raw goods that they have acquired through play into finished-goods such as the shown “Ice Armor.”

Quests in an MMORPG are much like those of the heroes of the medieval era. They are tasks taken on by players that yield some kind of reward if successfully completed; in most cases this reward is simply experience points that are automatically used to increase the level of the character.



Figure 3. *World of Warcraft*.

This image shows the quest system of Blizzard's game *World of Warcraft*. All of the player's acquired quests are arrayed on the left, while the specific information pertaining to the selected quest is presented on the right. If the player is successful in completing the task recorded on the right, he or she is rewarded the items at the bottom of the right section of the image.

Defeating monsters in-game is basically just what it sounds like, experience is rewarded when a player is able to take down a monster infesting the game world.



Figure 4. *Onyxia, in World of Warcraft*

In this image, a player and allies pose around the corpse of Onyxia; a giant dragon that is the final monster of one of the dungeons in *World of Warcraft*. As this is the final monster, it provides greater rewards than the previous monsters the players fight.

This however does lead to the idea of “farming” monsters. Farming monsters refers to the in-game practice of repeatedly defeating the same monster to quickly gain experience points to level up. This is done when a player feels as though he or she has fallen behind allies in level and must catch up so as to be useful and not a burden. Farming in the multiplayer classroom is in essence the practice of completing extra

credit assignments to counterbalance the less successful attempts of previous work in the class.

All of these terms and concepts lead to the grading system taken directly from an MMORPGs leveling system. For completing the previously noted actions, students are rewarded with experience points that are then converted into progression towards a final grade in the course. As Sheldon mentions, while there is no mathematical difference between awarding grade points and awarding experience, it is viewed by the student in a fundamentally divergent manner. The former is subtractive in nature; if subpar quality work is submitted, it will drag down the grade of the student. The latter is additive by contrast; if exceptional work is handed in, it will pull the student's overall grade higher than it was (Sheldon, 2012). The experience points allotted by the work add up to the next level (the higher grade), while in a point system any points lost on assignments take away from the optimal grade received by the end of the course.

1.4.2 Social Interactions in MMORP Games

This is a major concept within *The Multiplayer Classroom* as it is impossible to have a multiplayer experience with no significant interactions between the involved players. From an MMORPG's standpoint, the multiplayer aspects play varied and key roles to the success of this genre of game. For simplicity, only one MMORPG will be mentioned in this section: *World of Warcraft*. In *World of Warcraft*, there are a number

of ways for players to play the game, including solo play, as well as with any number of partners.

For starters, there is solo play within *World of Warcraft*. Despite the fact that at all times players inhabit the same space as one another, players are not forced into collaborative play. This decision is left to the discretion of the player and many opt out and simply play in a solitary fashion. These players defeat monsters, complete quests, and craft goods without the help of any other members of the *World of Warcraft* community. They raise their level and embolden their character through their own efforts.

Alternatively, you have parties and raids. A party within the context of *World of Warcraft* is a group of five players who come together to accomplish goals that would be far more challenging to complete by players operating independently. A raid is simply a party that contains ten or more players. This game scales its difficulty based on the number of players involved in the completion of certain tasks, so for certain scenarios a greater number of players is required for any hope of success.

Lastly, and mostly for the purposes of guaranteeing players easily accessible assistance from other players, guilds are formed. Guilds are a group of players that band together and sign a charter to establish an in-game association that provides support to all of its members. It is, in effect, a more permanent form of a player party. However, with that said, it does incorporate hierarchy within its membership. The guild must have an owner as well as officers to keep order within its social structure. These

people are responsible for the scheduling of events involved within the game as well as managing the guild's treasury.

Along these lines, two types of play develop within these defined social structures: player-versus-environment (or PVE) and player-versus-player (or PVP). PVE gameplay is modeled around players interacting with the content designed and implemented by the company developing the game. This would be the completing of quests and slaying of monsters in the game world, as these quests and monsters are not controlled by a player but are instead the game's built in artificial intelligence.

The alternative to this is PVP which is the combat between players. PVP can present itself in a number of different ways, but primarily PVP centers around battlegrounds. Battlegrounds are areas in which players compete for control of objectives and battle each other's avatars. Within the PVP setting, players can fight alone against other singular players or in groups against other groups of players.



Figure 5. *Warsong Gulch from World of Warcraft*

This image displays one of the more popular PVP forms in *World of Warcraft*: Warsong Gulch. In this game mode, players attempt to capture the opposing team's flag while simultaneously protecting their own flag. The player who is able to procure the opposing flag carries it, highlighting that player as a high priority target. In this screenshot, three players tasked with defense chase after an opposing player that has stolen their team's flag. In *World of Warcraft*, there are a number of other PVP game modes but they all share a core principle: score points by defeating your opponents.

All of these design concepts are represented in *The Multiplayer Classroom*. Students are expected to complete solo assignments, form "guilds" with clearly defined roles and hierarchies, and even compete against one another in player-versus-player assignments. Tasks that require the student to work on his or her own are designed around the previously mentioned solo player-versus-environment activities. These offer

very little in the way of player interaction but should be mentioned as they are key components of designing a multiplayer classroom. The more pronounced aspects of player interaction in this curriculum model are demonstrated through the concepts of guilds and the competitive PVP activities in MMORPGs.

1.4.3 Student Interaction in *The Multiplayer Classroom*

Sheldon models his classroom in much the same fashion as many of the prominent MMORPG games model their play structure. *The Multiplayer Classroom* bases all of the assignments on the previously mentioned design principles for player interaction. In this section, guilds and player-versus-player contact will be thoroughly analyzed and discussed.

Guilds, in Sheldon's view of the classroom, serve an integral role in the completion of learning objectives by the students. All participants in the classroom are partitioned into groups of four-to-six students and they decide amongst themselves what role they are to fill. The roles are drawn from the following: designer, writer, producer, tech lead, art lead, and marketing director (Sheldon, 2012). The designer is responsible for the base idea of the game; the direction of the game's development is his or her purview. The writer is in charge of the narrative aspect of the game as well as the formal write-up documenting the design, development, and testing phases of production. The producer assures that all of the arrangements are seen to; he or she

sets the meeting times and maintains adherence to deadlines. The tech lead and the art lead are accountable for the technical and art aspects respectively for the project. Finally the marketing director is in control of researching a marketing plan and the competition, as well as the group's chances for success. These hierarchies and roles directly correspond to the guilds commonly seen in MMORPGs.

These in-class guilds are responsible for completing quests, defeating monsters, and crafting essential items within the classroom. It is easy to see how students could complete quests (presentations) and craft (writing papers) collaboratively as these are fairly familiar practices within standard classrooms, but it is hard to imagine how a group of students could work together on a test without it being considered cheating. Sheldon has quite the nuanced approach for this however: draft an exam that has a section for solo play and guild play. In the solo section, students answered questions solely for their own grade, while in the guild section students answer questions for the sake of their entire guild. If one student in a guild is able to correctly answer a question, the entire guild is awarded credit. This incentivizes students to study together within their groups and better prepare each other for the exams. This provides a context for the students to study for the success of each other and in turn better prepared each student for the solo portion of the exams. It is far simpler to rationalize letting oneself down by not preparing for an exam, but it is far more difficult to let down a peer by neglecting to set aside ample study-time. This also imbued a sense of comradery into each study session, as the success of one guild member implies the success of *all* members.

In contrast, Sheldon also establishes competitive aspects within his classroom as well. The first iteration of this concept came in the form of a jeopardy-style game that involved not only a question-answer portion but also a physical component as well. The “Hat of Knowledge” (Sheldon, 2012, p. 169) was placed on a table several paces away from a group of nominated guild representatives and would function essentially as the buzzer in *Jeopardy*. The first student to grab the hat after the question was asked would be allowed thirty seconds to confer with his or her guild to find the answer. The representative would then repeat the guild’s answer and if correct would receive score for that round. If the guild failed to answer correctly, they would not be able to answer again for that question giving the remainder of the guild representatives the chance to offer their own answers.

This game was scheduled to be before the midterm exam as a study session for students. The intent was to go over the content of the test in a more hands-on, group oriented manner; the goal for Sheldon was to ensure that students do not forgo the study session because they feel they do not need it to pass the exam. Sheldon offered to his students an unspecified reward for besting their competitors which the students received at the end of the semester. Unfortunately, since the reward was neither tangible nor extrinsic, Sheldon felt that it in many ways fell short of its intended mark. To rectify this, Sheldon’s next iteration offered experience points, in differing tiers based on each guild’s standing at the end of the competition, so that students could see an immediate value in participation.

He also received a complaint about the structure of the competitive game as it emphasized the physical aspect of the exercise over the intellectual portion. In response, he drafted a version of the game that the students found so complicated that the class overwhelmingly voted to stick with the original. He was content with the choice presented to the undergraduates, but he mentions that further iterations would, in all likelihood, involve a penalty to the groups that relied on their representatives speed without having the correct answer.

Player interaction, be it cooperative or competitive, offers a palpable lifeline to the students for when they are struggling, or simply when they need a push to invest time in their studies. A student is far less likely to ignore their studies if the fate of their peers would be adversely affected. Students are also far more likely to participate in preparative exercises if the reward is extrinsic; their grades increase visibly when they invest the necessary time.

1.4.4 Offering a Narrative-Driven Approach to Learning

The Multiplayer Classroom is perhaps most innovative from an educational perspective because of its role playing elements. This presents itself in a number of ways. As mentioned before, students are expected to create an avatar, rich with backstory, that propels the student as player through the educational material. Non-player characters (or NPCs) are present to give the students' avatars quests and

goals within the game environment, which directly translate to in-class assignments. Guilds exist as entities in the game world that work together to complete missions provisioned by the NPC inhabitants of the game-world. What this means in practice is that, even down to a fundamental level, the student is immersed in a world that helps to distract from the intrinsic learning going on around him or her.

First, in *The Multiplayer Classroom* as student is expected to create a previously mentioned avatar. Their avatar is a character that perhaps embodies their own ideals, or perhaps is based on the character archetype they wish to embody within this world. This means that the student is expected to name and define this avatar with a backstory. The avatar then becomes a direct link for the learner to the material and gives them agency within the classroom.

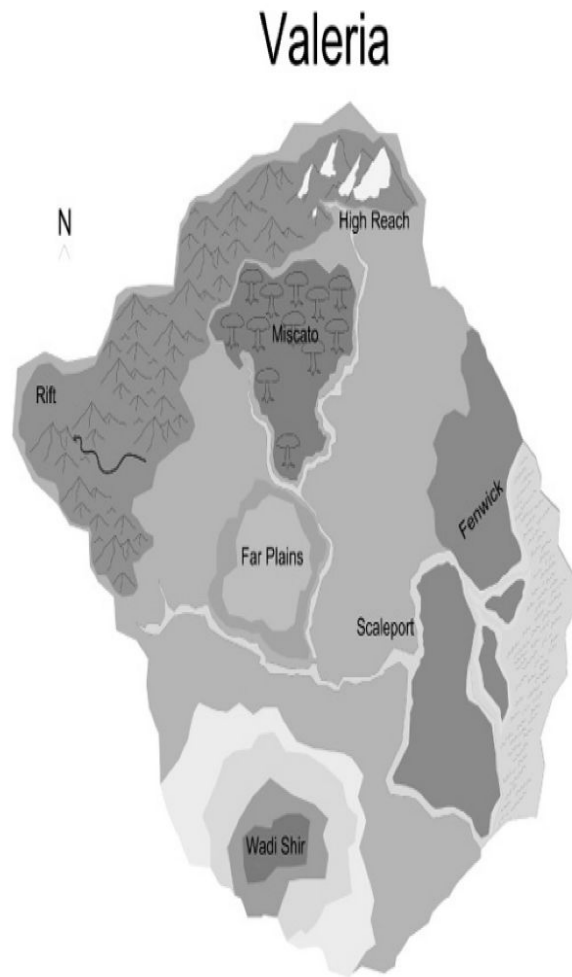


Figure 6. *Valeria, from The Multiplayer Classroom*

Next, the instructor may draft a number of NPCs with whom the students' avatars may interact and receive direction. The NPCs offer a narrative to the players that gives them a game-based context for meeting the educator's learning objectives. Along with the creation of the NPCs, Sheldon also conceptualized a world that the players and NPCs would operate within.

This world was named “Valeria” and was broken up into six distinct geographical zones: Wadi Shir, Scaleport, Fenwick, High Reach, Miscato, and Far Plains (Sheldon, 2012, p. 153). Together, the students drew a map to represent these regions. The students were then distributed among the six zones, deemed citizens of these realms, and went on to form the guilds of the classroom. Sheldon decided which group a student should be in, assuring that a balance of different skill sets was maintained in each.

These region-based guilds would be introduced to the NPC that was specific to their region and a distinct narrative surrounding these characters was established. From this a narrative linked to the classwork was born, where all the learning objectives of the class-related activities had a context tied to the world of Valeria, as well as the students’ avatars and the related NPCs. This in turn, would form the basis for the methodology of this thesis.

2 Methodological Approach

For this study, this author attempted to apply as many of the previously stated principles denoted within *The Multiplayer Classroom* as was feasible in the context of a high school biology course curriculum. The curriculum was developed with the help of several of the members of the biology department of Farmington High School in Farmington, Connecticut.

The biology department had previously attempted to gamify portions of the course without much success. Problems arose due to a lack of knowledge concerning the principles of game design. Their original endeavor involved the use of narrative following the lives of the members of a fictional family interested in the precepts of basic biology. The scope of the project was based around the first three sections of their program of study. It is necessary to outline the topics covered to better explain the decisions made towards the gamification of these sections.

2.1 Biology Course Topics of Study

The gamified portions of this class were restricted to the first three sections of the course. The first section was short, covering the basics of classroom expectations, safety protocols, and the tenets of the scientific method. The second section of this course was segmented into five lessons: living and nonliving matter, Linnaean classification, dichotomous sorting, cell structure, and animal and plant cells.

To start, students must learn to differentiate living and nonliving matter. Within this lesson students are taught to recognize the defining characteristics of these two categories. The exercise given to students has them brainstorm qualities intrinsic to life. They share their ideas with other students and offer possible problems with those assumptions. For example, a student might state that to be considered living, an organism must have the ability to reproduce with another member of its species. The

other student could then comment on the existence of asexual organisms and the positing student would then be required to revise their list.

The second lesson defined the practice of Linnaean classification to the students. Linnaean classification refers how biologists classify, sort, and name organisms. It creates a hierarchical list of specimens found in nature. The students are taught the acronym KPCOFGS which stands for kingdom, phylum, class, order, family, genus, and species; the higher in the list, the more general the classification. For example a human would place as follows: kingdom Animalia, phylum Chordata, class Mammalia, order Primates, family Hominidae, genus Homo, species Homo sapien (Swafford, n.d.). In this lesson, students are expected to prove proficiency in this scientific naming convention and denote the importance of assigning organisms scientific names.

The third lesson defines the structure of a cell and indicates all of the organelles found within a cell. These organelles would be the cell wall (found solely in plants and is responsible for support and protection of the cell), the cell membrane (found in both plants and animals and is responsible for support and protection of the cell), the nucleus (central control center of the cell), the nuclear membrane (controls the movement of materials in and out of the nucleus), the cytoplasm (supports and protects the organelles found inside the cell), the endoplasmic reticulum (responsible for carrying materials throughout the cell), the mitochondria (breaks down sugar molecules for energy), the ribosome (protein producer of the cell), the vacuole (food, water, and waste storage), lysosome (responsible for the breakdown of larger food molecules into smaller ones), and the chloroplast (only found in plant, produces food from the energy drawn

from the sun). Students are expected to name and define these functions of cell organelles (Westbroek, 2000).

The fourth lesson covers the concepts surrounding a dichotomous key. A dichotomous key is a scientific tree of characteristics that helps to subdivide organisms into smaller groups. For example, an animal can be divided into two large groups, those with red blood and those without. Those with red blood can be further divided into animals with hard bodies such as insects and those with soft bodies. This can continue almost indefinitely until the scientist creating the distinctions is satisfied with how detailed it is (Akuna et al. 2008). For this lecture, students are expected to complete an exercise much like the one just outlined, in which they separate animals into distinct categories based on a key.

The final class is devoted to the differences between animal organisms and plant organisms. This was previously outlined in the cell structure definition, but the student is expected to complete an exercise outlining the differences and similarities between these two types of cells. Once finished with this lesson, a formative assessment is given to the students covering all of the topics in this section.

The third section covers a broad view of biomolecular science. When completed, students are expected to understand and recognize the structures of proteins, carbohydrates, lipids and nucleic acids. They should also be proficient with their role in living systems. This includes the ability to predict their movement through cell membranes and across gradients as well as their relationships with the organelles of cells.

2.2 Translating *The Multiplayer Classroom* to a Biology

Curriculum

This author focused on a few of the ideas exhibited in Sheldon's work, primarily the inclusion of a narrative within the classroom as well as the differentiation of competitive and solo-play quests. To provide the former, an overarching narrative was established that followed a character based in a generalized science fiction setting devised by the author of this thesis.

The character, dubbed The Professor, was created with a snarky and often sarcastic sense of humor and tends to playfully criticize the student. He is introduced to the student by landing a comically anachronistic spaceship directly in front of the player. Getting out of the spaceship *The Professor* grouchy asks for assistance. Seeing the student's biology book, he assumes that he or she is a subject matter expert and given his need for a master of biology, offers adventure.

From this, a narrative style is set up with The Professor acting as the non-player character previously mentioned in the section overviewing *The Multiplayer Classroom* and the player taking the role of the first person perspective of the writing. Together the student and The Professor travel the known universe dealing with the biology related issues that arise from this endeavor.

These issues were directly related to the course materials involved and because many of the lessons had an experimental component this narrative served as a context for the classrooms to complete these active assignments.

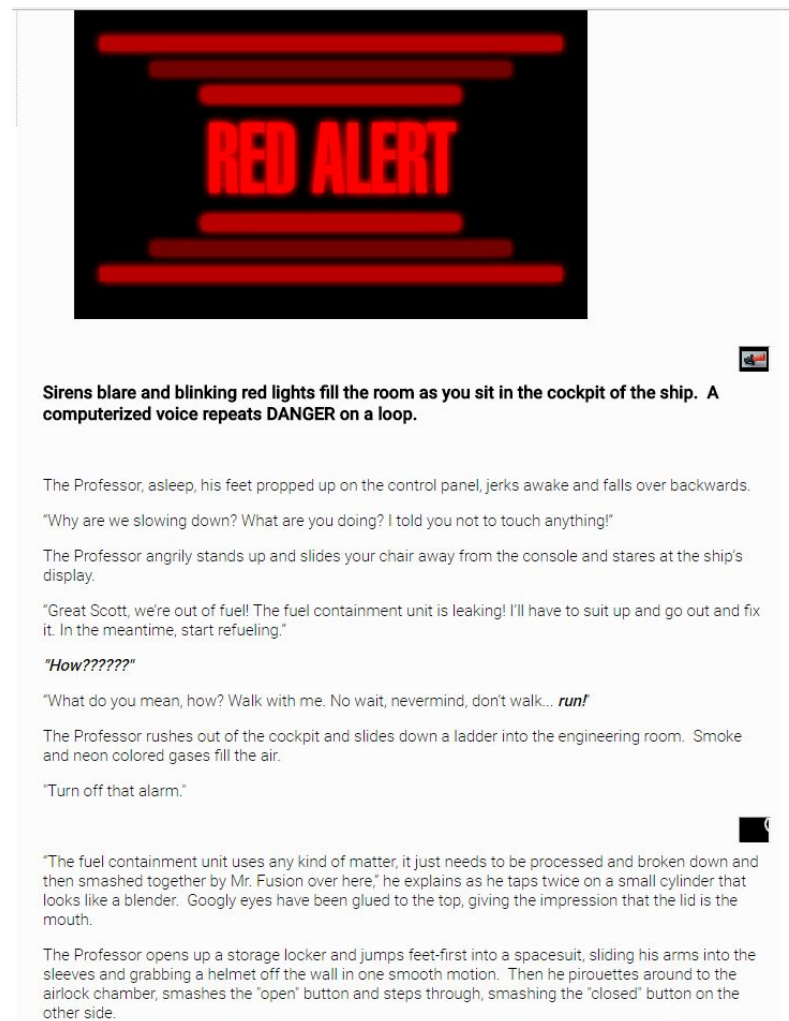


Figure 7. The Professor Narrative Overview

This image is a screenshot of what the students would see when sent on "missions" by the teacher. This author drafted the narrative for each assignment and made sure to keep the expected educational activity the focus of what was going on in

the story. The image displays the first lesson of section two in which students must prove their understanding of the differences between living and nonliving material. The narrative has the students helping The Professor in refueling the spaceship with specified materials as his reactor can only process nonliving materials.

You note that your Biology textbook identifies the following as **Characteristics of Life**:

1. Made up of cells
2. Ability to reproduce
3. Use a universal genetic code
4. Grow and develop
5. Obtain and use materials and energy
6. Respond to their environment
7. Maintain a stable internal environment
8. As a group, they evolve or change over time

>>Take notes on these Characteristics of Life. You may want to include a description of these characteristics in your journal. If you need help, here is a starting point for research. You may also refer to your textbook for additional information.

Once you feel confident that you understand these characteristics, you can take a self-test [here](#) or [here](#).

Alright. You have what you think are a tight set of rules that you can use to determine if something is living or nonliving. You go find the sample container, which is bigger on the inside, and packed with what can only be described as "stuff." You randomly reach in and pull out a peach pit. So, you ask yourself, how do I decide if it's living or nonliving?

>>Obtain a Living, Nonliving, or Dead data table to help you decide which items from the box of "stuff" can be put into Mr. Fusion and used as fuel for the ship. Remember, you need 400g of **nonliving** material. Record each object from the box on your data sheet and use the checklist to label each object living (L), nonliving (NL), or dead (D). Then highlight the nonliving and dead objects on your data sheet, and record the items that you will put into Mr. Fusion in your journal.

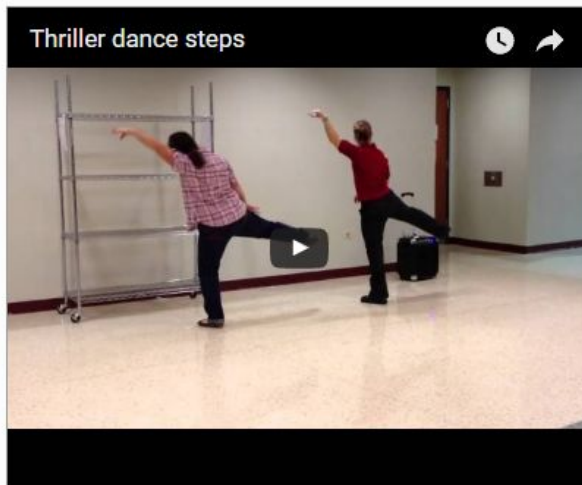
Figure 8. Lesson Overview

This screenshot shows the inclass assignment for this lesson. It has the students create a spreadsheet of items, denoting each by whether it is living, nonliving, or dead (implying at some point the material was alive). This portion is found after the narrative section.

3. COMPETITIVE PATHWAY OPTION:

To earn 5XP, complete the following challenge of learning a portion of the dance to Michael Jackson's "Thriller" (As zombies were once alive but are now the living dead - think about how THAT fits into our definition of living things!)

Watch the following video from 20 seconds through 1 minute. You must be able to perform this 40 second portion of the Thriller dance to your instructor. Good luck!



Complete this challenge before you press submit!

Figure 9. Competitive Path Overview

If the student selected the competitive path with The Professor, at the bottom of the lesson they would see the day's challenge that must be completed before they submit their work. Shown in the image above, this lesson's challenge was to have a dance competition with the other competitive path students.

It became clear that a single non-player character would not be enough content for a diverse group of students, so a second character was created that paralleled the story of The Professor. This character was named Doc Brunus and instead of flying through space with him, students would travel throughout time with this far less sarcastic NPC. The idea was to offer the students more avenues of choice within their learning, but eventually Doc Brunus helped solve a problem that arose from the

involved teachers' dislike of forcing competition on the students. This issue will be covered later in the paper but it is important to note now, as Doc Brunus took on a new role within this study that he was not intended to fill. His original conception was purely one of applying in-game player choice to get students more involved in their learning.



"My history is a little fuzzy, but I am almost certain that dinosaurs were wiped out sixty-six million years ago," he posits as he points towards a pen holding what could only be brontosaurus. It is astoundingly massive. All the movies you have seen, books you have read, memes you have perused relating to dinosaurs don't do this beast justice. "Well, sixty-five million from your perspective. It's sixty-six from mine. But no matter. We need to get these dinosaurs back to their time. They should be extinct by now, and the longer that they stay in this time, the more that we rewrite history, there could be devastating consequences!"

"I'm going to need your help again on this one. Here, take this." He hands you a tablet opened to an input screen that says PASSWORD with a blinking cursor next to it. "The DeLorean can take these dinosaurs back to their time, but the coordinates seem to be password-protected. We can't bring them back unless we crack the code!"

You do what you always do when you forget your password, and click on the "Password Hint" button. The device shows you an image of what seems to be a sea cucumber.



You decide to give it a try. "s-e-a-c-u-c-u-m-b-e-r," you type. ACCESS DENIED. Hmm, maybe it requires a number and a special character? You try again, "s-e-a-c-u-c-u-m-b-3-r-!" ACCESS DENIED. You sigh in frustration.

"No, no, no! You're going about this the wrong way! In the future, you are a highly esteemed biologist, after all. I'd wager that you need to type the password in using proper binomial nomenclature!"

Binomial nomenclature? What's that about? You wonder. Once again, you are thankful that you've got your biology textbook handy. You open to learn more about Biological Classification.

Figure 10. Doc Brunus Narrative Overview

In this image the narrative for the third lesson of section two is displayed following the misadventures of Doc Brunus. The player is sent back to the ancient city

of Hierakonpolis because Doc Brunus' time machine has picked up on a chronological anomaly. It becomes apparent that anachronistic species of animals have infested the city's menagerie and threaten to damage the time-continuum. The game's heroes, Doc Brunus and the player, must classify which animals do not belong in this time period so that they can be rounded up and returned to when they came from.

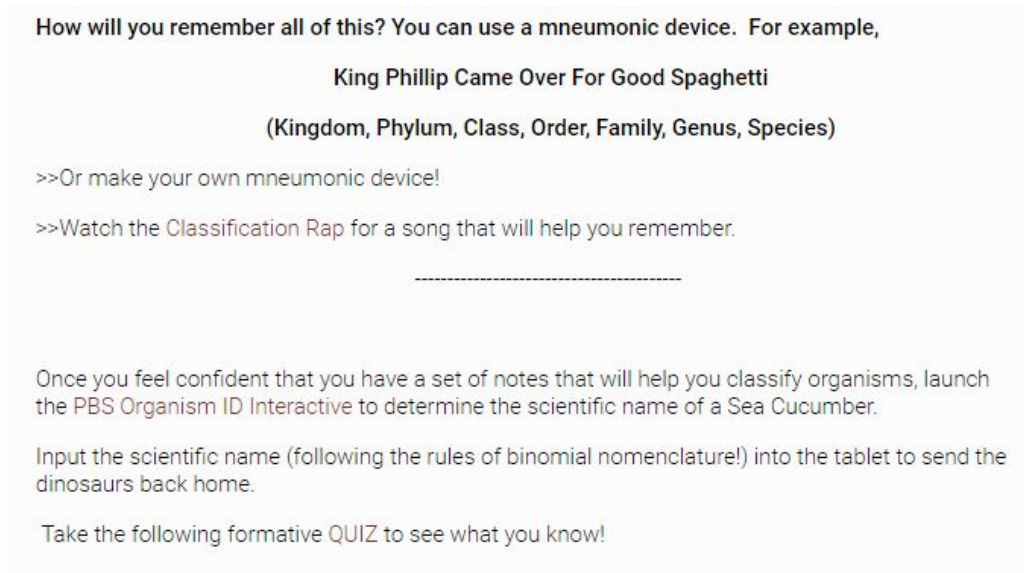


Figure 11. Lesson Overview

To do this, the student must learn Linnaean Classification and prove their proficiency in it. As shown in the image above, students are instructed to create their own mnemonic device to help remember the hierarchical order of Linnaean Classification. They can then use the interactive organism identification module developed by PBS.¹

¹ Since the assignments designed for the students are too long to include directly in this thesis, an appendix can be found at: https://drive.google.com/drive/folders/OB__lndBITuLNZFoxbTZ6WVN3bnM?usp=sharing

At the bottom of the page, students that follow the introspective path with Doc Brunus are directed to complete a reflection on a question pertaining to the given lesson. In this case the question that they are expected to answer is “why has our system of classification changed numerous times since the time of Linnaeus?” The students are given related material to assist them in forming an argument.

Despite the educator’s compliance with these implementations, many aspects of *The Multiplayer Classroom* were not possible to execute in this project due to constraints of scope and reticence on the part of the teachers involved. Most pointedly for this researcher, was the inability to carry out a system of solo-missions, group missions, and competitive missions. Perhaps one of the most crucial elements of Sheldon’s work was the inclusion of these three elements as inherent portions of the classroom. Unfortunately, it was hard to convince the teachers on the biology team to upend their entire curriculum and then in turn, spring this on the student.

The teachers were concerned that expecting students to compete would create resentment in the classroom. They admitted that many of the students that they had worked with in past classes were averse to competition. They would rather do the work by themselves and go at their own pace. This author did not think this was completely unreasonable, so a compromise was formed. Doc Brunus, the kind and patient character, would lead the “Introspective Path” which would be wholly single-player. The Professor, the sarcastic and at times rude character, would be reserved for competitive play. Each of the assignments would differ slightly for each track that the students chose. Typically the Introspective Path would involve short writing assignments that

were related to the lesson's topic. The competitive path would include some form of contest upon completion of that day's lesson. These activities would range from dancing to the more science-themed, such as a board game about evolution. This seemed reasonable enough and close enough to the researcher source material that it could still be an acceptable modification. However, cooperative group-play never found its way into any of the lessons.

The other element that was not fully included in the final version was the student's avatar. One of the lessons in the first section had the students create an avatar, but no backstory was bestowed upon this player character nor was the avatar ever truly used within the classroom.

2.3 Platform Used for Gamified Educational Material

The platform used for this research was decided by the biology department as they had some experience in using it. They had attempted to use this environment to develop a curriculum in a previous academic year without much success. The platform is called 3D GameLab and is developed and operated by GoGo Labs based out of Boise, Idaho. GameLab is a "gamified learning platform that applies game thinking and mechanics, such as quest, experience points, levels, ranks, player cards, open badges, and guild sites to support engaging and persistent learning. As players quest, they literally level up toward their educational goals. We incorporate content, tools, and

teacher training in one platform to provide an integrated experience to help teachers to gamify their class” (Dawley, n.d.). This is the mission statement for this company’s product. It was created by Lisa Dawley who was previously a professor at Boise State University; this environment was developed by a teacher for other teachers to modify their classroom.

Given that 3D GameLab’s principles are not unlike *The Multiplayer Classroom* this seemed an acceptable development environment to work in for the purposes of this thesis. That being said, the teachers of the department had already decided to use this product before this author had agreed to assist. 3D GameLab did allow for a flexible structuring of the narratives in which students that had chosen their NPC at the beginning of the class would only be able to see that particular set of educational narratives.

3 Data and Analysis

This section will outline the approach taken to evaluate the successes and failures of this thesis. To determine this, both qualitative and quantitative data were taken from the students through survey questions and student grades respectively. Several questions were drafted to ascertain the students’ opinions of this thesis’ modus operandi which will be defined in detail in a later section. In terms of quantitative data, the previous year’s grades of this same class were used as a control group. This author

believes that if students are conveyed the relevant information in the course material through means of a gamified learning experience, they would perform better than their peers from the preceding class. It was expected that these students would have a greater level of participation and motivation in a classroom with a narrative.

3.1 Quantitative Data

Honors	2015-2016				
Student total=	129	Mean =	30.20	Median =	31
Male =	77	Mean =	30.58	Median =	31
Female =	52	Mean =	29.63	Median =	30.25

Honors	2016 - 2017				
Student total=	141	Mean =	31.01	Median =	31.5
Male =	74	Mean =	31.15	Median =	31.5
Female =	67	Mean =	30.85	Median =	32

College Prep	2015 - 2016				
Student total=	76	Mean =	26.26	Median =	26.5
Male =	51	Mean =	26.21	Median =	26.5
Female =	25	Mean =	26.38	Median =	27

College Prep	2016 - 2017				
Student total=	57	Mean =	26.31	Median =	27
Male =	42	Mean =	26.30	Median =	27.25
Female =	15	Mean =	26.33	Median =	27

These four spreadsheets display the data accumulated from the course grades. The spreadsheets are separated into two distinct categories: college prep, the orange table, and honors, the blue table. The main difference between the college prep and honors is that the latter is an accelerated program. The honors classes finished the material about two to three weeks prior to college prep classes. It is also important to note that the maximum score that a student could attain in either class was a thirty-five.

As far as data analysis is concerned, the only real changes between the two academic years was present in the honors course. A slight improvement was recorded across each of the demographics within this class category. The college prep course had roughly the same values in every field. In the 2015-2016 academic year, the average score of the college prep course was a seventy-five percent which was mirrored in the 2016-2017 academic year. The median varied slightly from a seventy-five percent to a seventy-seven percent. When separated by gender roles, this group of students maintained this same stagnation.

For the honors course students, there was a slight growth from the 2015-2016 academic year and the 2016-2017 academic year. The average grade for students in this category in the 2015-2016 academic year was an eighty-six while students in the 2016-2017 academic year had an overall average of eighty-nine in the course. Within this demographic, however, it appears that the female students had a significant change in their course grade averages. An increase of four percent, from eighty-four to an eighty-eight percent, was noted between the two academic school years. Given this, it should also be noted that a greater percentage of the class in the 2016-2017 school year was female, just under fifty percent of the students. The previous school year female students made up barely forty percent of the class. This may simply be the demographic breakdown of the school though, as the male-to-female ratio of the college prep course was similarly weighted towards male students.

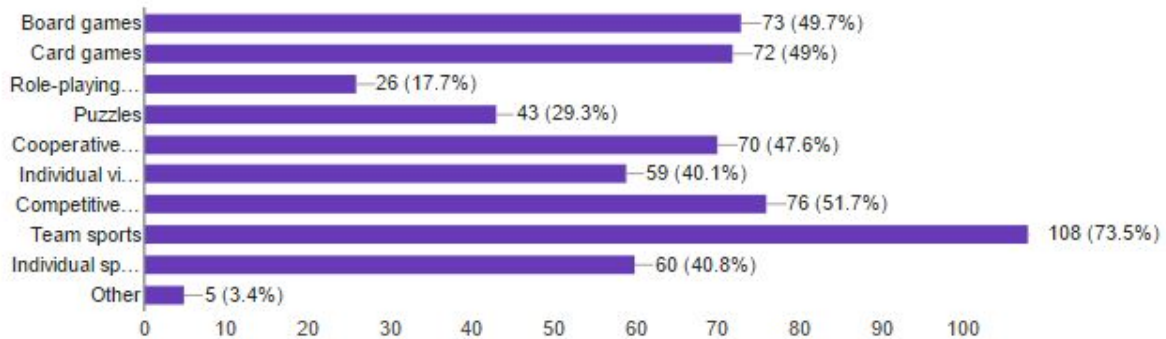
3.2 Qualitative Data

To determine the efficacy of this study, a qualitative inquiry was given to the students of both the honors and college prep courses. This survey was designed to be lightweight so that the students would not feel any question fatigue and answer as honestly as possible. It was a great concern to this author that if given a long and extensive set of questions that after the first few questions posed, they would be more interested in finishing the questionnaire than providing useful feedback. The question topics were as follows: the specific version of course enrollment (honors or college prep), their preconceived notions regarding science as a whole, their gender, the types of games that they are familiar with, their NPC choice, their confidence towards their performance, and their study habits. This totalled eleven questions with an optional comments section for students to provide responses not included in the questions. For the most part, this information was apropos with a only few outliers not taking it very seriously; the students were, after all, high school age.

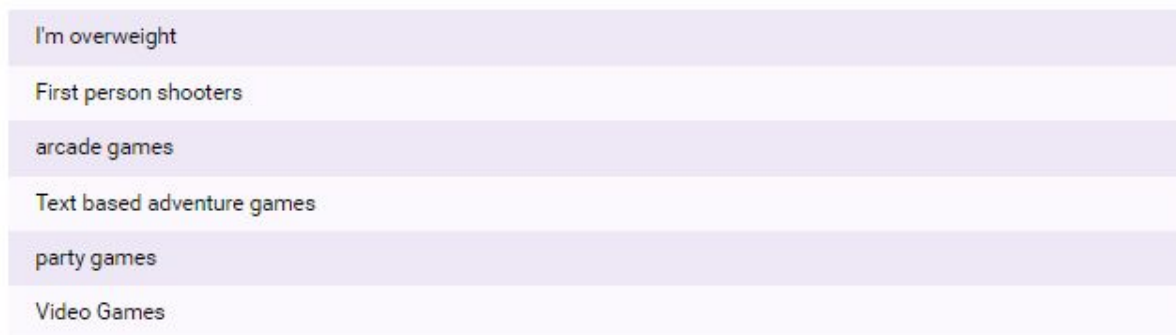
First, this author will go over the responses to the questions. The first set of questions were somewhat related in that they attempted to establish a baseline for the demographics a given student fell into. Just over eighty percent of the students enrolled were in the honors program with almost sixty percent male. Of the one hundred forty-seven responses, fifty-four percent of the participants held a positive view of the academic realm of science, with only eleven percent reporting they disliked

science. The remaining thirty-four percent answered they had neither preferred nor disliked science.

What type of game do you play? (147 responses)



If you answered "Other", what other type of game do you play? (6 responses)



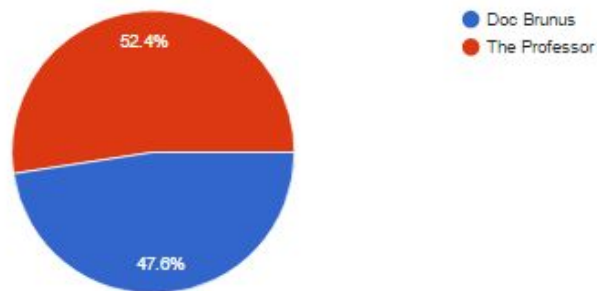
For determining a student's experience in games, a more open-ended question was posed; the students were asked what types of games they played regularly, offering examples such as board games, role-playing games, cooperative and competitive video games, team and individual sports, and a comments section that

allowed for students to write in something the questionnaire may have missed. Every single student (apart from one that cited he or she was “overweight” in the other section) stated that they had played at least one of the stated types of games. The overwhelming answer given was team sports with almost seventy five percent reporting they were a part of an organized competitive sports league. That being said, almost one in five students did admit to having played a role-playing game at least once in their lifetime. Given that much of *The Multiplayer Classroom* is rooted in the idea of role-playing, it was helpful to know that some of the students had some relevant knowledge towards the concepts being applied to their course material. It is also important to note that every student had some experience in playing a game. It is doubtful that many of the students could equate playing an organized sport to the gamification of their classroom. This did, however, speak to their ability to willingly accept an overarching set of rules applied to a given experience.

The questions that followed were aimed at determining the platform’s success in the classroom. The students taking the questionnaire were first asked if the choice posed to them affected their engagement in the course. They were then asked whether they selected the competitive character, The Professor, or the introspective character, Doc Brunus, during the second and the third sections of the class. They were then asked whether they believed that the chosen character effectively assisted them in following course material. In response to the first question, students overwhelmingly responded that this choice made no difference on their engagement (fifty six percent of

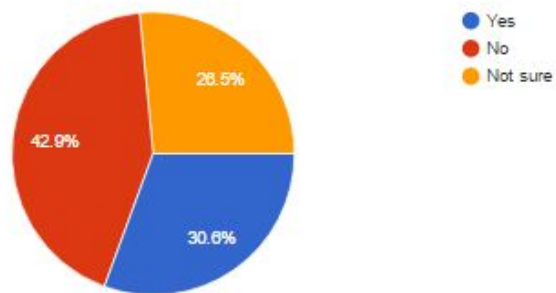
the students). That said, more believed it improved their perceived agency in the course than those that believed it did not (twenty six percent to seventeen percent).

Which character did you choose in Section 2? (145 responses)

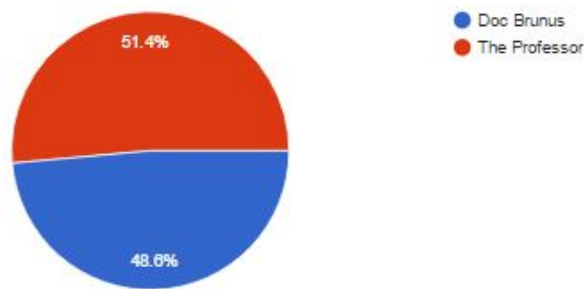


Did going on missions with this character help you maintain focus on the content?

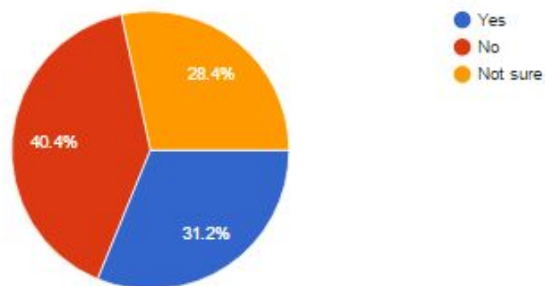
(147 responses)



Which character did you choose in Section 3? (140 responses)



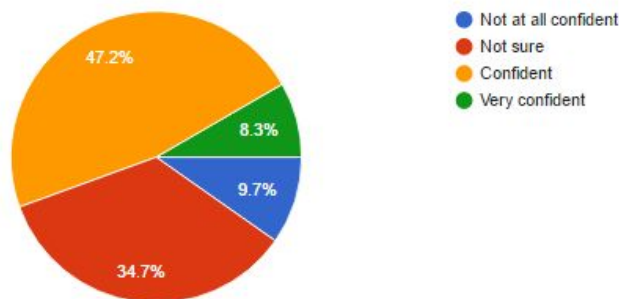
Did going on missions with this character help you maintain focus on the content? (141 responses)



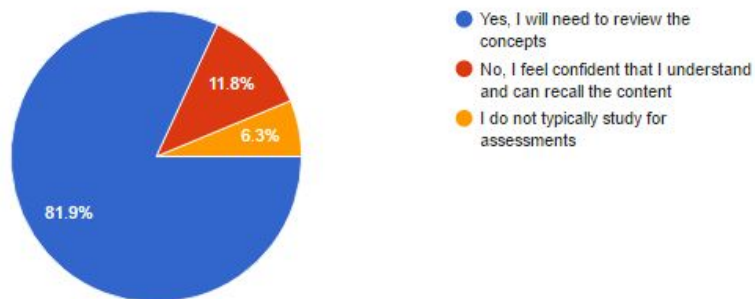
As far as student choice was concerned, in both sections the majority of students opted for the competitive path with *The Professor* than for the introspective path with *Doc Brunus* (at about fifty two percent in each section). Furthermore, almost a third of the class in both sections (thirty one percent in both cases) believed that the missions taken with their respective character had a positive effect on their ability to focus on the material. The greatest plurality of students (forty percent in section two, and forty three percent in section three), however, felt the opposite. Based on their responses, this portion of the students tended to

ignore the narrative portions of the assignments; instead they skimmed the educational material and proceeded straight to the in-class assignment.

How confident do you feel about your performance on the upcoming assessment on this content
(144 responses)



Do you plan to study for the assessment? (144 responses)



When asked about their perceived future performance on the upcoming assessment, fifty five percent believed they were adequately prepared, ten percent believed they were not at all ready, and thirty five percent were unsure. It is difficult to attribute the preparedness of the majority of the class to this study however, as the

quantitative data does not corroborate that position, nor does the comments section of the survey.

The comments section of the survey was supremely helpful in determining this project's efficacy. For the most part, it was filled with constructive criticism and helpful reviews of the experiences of the students. A significant portion of the complaints centered around the lack of interactivity in section three. This was, in this author's opinion, an issue with that section as a whole. The second section had physical activities that the students were expected to complete, be that experiments involving microscopes or Linnean Classification charts, there was something that the students were required to do in class. Section three was purely made up of lectures with no active component. This led the narrative-based delivery method to be somewhat cumbersome. Students did not want to read extra material if they did not have to, which is reasonable. One such student commented, "I liked the idea that the information was presented as a game, but sometimes there was too much background that it made it easy to lose focus." As the entire purpose of the study was to pose the information in a way that facilitated higher comprehension and learning, it's easy to see that this overabundance of information ended up hampering the students' ability to maintain focus on the course material.

The other main issue presented by students was the content of the narrative. Many students had very little interest in a science-fiction setting and made that known in the comments section. One such student stated, "Most kids are [not] into the science fiction theme, and [would] have a better experience doing a game lab that was with a

realistic story line.” It was this researcher’s belief that the most interesting way to present scientific course material was in the guise of a science-fiction writing style. This could stem from one of two major flaws in the project. Either the design of the narrative was not generic enough to encompass the interests of high-school learners, or it was not engaging enough in its presented form to keep their attention.

The remainder of the analysis is far more focused on what could be done better for future studies in this field. As such, it will be covered in the next section.

4 Post Mortem

This study proved flawed in a number of ways, but it is this author’s hope that further studies within this field can avoid the pitfalls presented here. First and foremost, the greatest misstep made was not approaching the narrative elements with universality in mind. Obviously, it is virtually impossible to design anything with all users equally accounted for, but certain design choices can be made to generalize the material enough to partly consider all end-users. For one thing, it did not occur to this researcher that both of the characters were male until after deployment. It’s hard to say whether this would have made any change in the decision making of the players, but it at the very least offers a more diverse landscape of choice for the students.

In addressing this lack of choice, it could be helpful to add a number of other narrative settings. As stated, the major complaint many students had for this project

was a disinterest in science-fiction material. In the future, this curriculum could incorporate more genres to the players. This could present itself in a number of ways, such as film noir, fantasy, even non-fiction historical settings. This does pose a problem in its solution however; this forces any educator to adopt this teaching style to do a great deal of extra work on top of their lesson planning. Scoping this project was a huge consideration in the preparation stages and creating just two divergent narratives for the students to choose from took several months to develop. If the teachers involved did not have the outside help of this author, it is unlikely that they would have tackled this project.

Further, when interviewing the teachers that adopted this gamified curriculum, there was a consensus among them that while the learning targets may have been met, they simply did not see enough growth in the students to warrant the amount of development time. They mentioned that they planned to use the first two sections in future classrooms, but the third section would likely be removed or reworked. They had the same misgivings as the students, that there was an overload of reading involved in that section that detracted from the learning.

As far as working alongside the teachers of this biology department, this author found that a number of things had to be scrapped. It was difficult to convince these educators to adopt the competitive and cooperative multiplayer aspects described in the *The Multiplayer Classroom*. These teachers had fairly concrete concepts of what they wanted in their classrooms; they knew what they felt belonged and what did not. They were not comfortable with the idea of forced competition, which as stated, was why one

path focused on single player and the other focused on competition. This made it rather difficult to stick to the precepts of Sheldon's work, but with that said, they were amenable to most of the other concepts this author proffered.

Along this line of reasoning, the decision to make the competitions the students would participate in a secret until after they had chose this path seemed damaging to the choices offered to the students. In the vast majority of informal conversations with the students, a consensus formed in those that chose the introspective, single-player path. Due to the uncertainty surrounding the competitive path's contests, it was, in their minds, better to "play it safe" than risk a damaging grade. This decision may have been out of the researcher's control, but it should be noted that any decision (be it over competition or otherwise) should be clearly outlined. If a student has ample information on the context of a choice, it gives that student the ability to fully understand the impact of possible outcomes.

It is this author's belief that these decisions had an unfortunate muddying effect upon the material. Because a second narrative had to be written for the students uncomfortable with competition, a significant amount of time was lost to extended development. That time could have been used to better implement gamified tasks and competitive elements for all of the students, rather than just a portion of them. If this had been the case, only one non-player character would have been created and each in-class assignment would have been tailored to be either player-versus-player or player-versus-environment. Each student would then be exposed to both solo-work and group-work as there would be a preset allotment of each. Modifications could be made

during the semester on the graded weight of these competitions as well. This would help to minimize the worries of the students who are concerned about any adverse effects that the competitions might have on their grades. This design approach would also eliminate the problems that arose from the lack of information provided on the competitive elements.

Furthermore, applying more time to drafting a single narrative allows for better iterating of the material. The game can be edited and modified to better fit the course curriculum and this ensures that the product presented to the students has been thoroughly proofed. Regardless of the story genre, the game elements would be properly tailored to the educational subject matter. Instead, a more robust editing process would eliminate any design flaws before the students found them.

This issue underscores the most prominent weakness of the study: its scope. This researcher, in the design phase, planned a project too large for the allotted time. It was much too difficult to implement the number of aspects from *The Multiplayer Classroom* that were included in the design; this stretched the resources of the project so that much of the implementations felt rushed. In large part, this was due to the expectation of the biology department. They were interested in a learning environment akin to Sheldon's work, starting from the ground up. Since the teachers agreed to the study for its application, it was more important to provide a product that they signed off on, than to reduce the scope. Because of this, the extra narrative was incorporated for students uninterested in the competitive elements.

Ideally, the project would have been much more contained. This researcher would have added far simpler game elements rather than an entire branching narrative. This would have taken the form of simple competitive, cooperative, or solo games. These games could have been as uncomplicated as a trivia quiz based on a website such as Sporcle. Students could submit their results and have them added to a high-score board, viewable to everyone taking the course. The teachers could also have a group-based trivia day to help study for an upcoming exam. This style of gamification would have been far simpler to plan and could have left the biology team and this author time to test and modify the game designed portion of the curriculum. It also would have eliminated the complications that emerged from the third section. The students would not have had to read through two separate portions of text; instead they would read through the information presented in the textbook and then reinforce that knowledge through lightweight quiz games.

Lastly and perhaps most importantly, a closer look at the demographics should be applied to the design process. Some background information is necessary to approach this issue; the environment of Farmington High School is one of achievement. Just from the demographic numbers outlined earlier, it is clear that the bulk of students would prefer an accelerated curriculum to the speed and environment of the college prep course. These students are used to doing the work presented to them and tend to skip past the game elements, straight to the educational material. The main problem this poses is that if given that the intent of this study was to increase focus and engagement, then the design of the survey was unhelpful in gauging the opinions of

those that might benefit from this the most. A greater emphasis within the questionnaire should have been placed on the students enrolled in the college prep course. Since these students were not interested in the accelerated program of the honors course, they were likely less engaged with the given material that is covered within the classroom. It is hard to tell if this gamified curriculum was successful in reaching these students as the survey did not account for this idea. While demographics were determined by the student body, the answers were anonymous and not linked. It would have been better to create two separate questionnaires, one for the honors course and the other for the college prep course.

5 Conclusion

Despite these complaints, however, it is this author's belief that this project was in some part a success. With almost a third of the student body in these courses showing that this approach was perceived as helpful, it can be said that despite the flaws, this project accomplished what it set out to do. While it may only be a marginal victory, it does offer a framework for further development by interested researchers. The key aspects that should be addressed in the future should be greater universality and better information gathering. That said, with slightly more applied time on the part of an educator, *The Multiplayer Classroom* is a helpful way to motivate and engage students.

Bibliography

Mcleroy, C. (2008, August 27). History of Military Gaming. *Soldiers Magazine*. Retrieved January 15, 2017, from https://www.army.mil/article/11936/History_of_Military_gaming

H. (2012, January 18). Herodotus on Lydia. Retrieved January 15, 2017, from <http://www.ancient.eu/article/81/>

Allen, R. (2017). *America's Digital Army Games at Work and War*. Univ of Nebraska Pr.

Mead, C. (2013). *War play: video games and the future of armed conflict*. Boston: Eamon Dolan/Houghton Mifflin Harcourt.

Shaban, H. (2013, October 10). Playing War: How the Military Uses Video Games. Retrieved from <https://www.theatlantic.com/technology/archive/2013/10/playing-war-how-the-military-uses-video-games/280486/>

Stege, L., Van Lankveld, G., & Spronck, P. (2011). *Serious Games in Education* (Master's thesis, Tilburg University, 2011) (pp. 1-9). Tilburg, The Netherlands: Tilburg University.

Decker, A., & Lawley, E. L. (2013). *Life's a Game and the Game of Life: How Making a Game Out of it Can Change Student Behavior* (Master's thesis, Rochester Institute of Technology, 2013). New York City: Association for Computing Machinery.

Sheldon, L. (2012). *The multiplayer classroom: designing coursework as a game*. Boston, MA: Course Technology.

Westbroek, G. (2000, June 15). Cell Organelle Table. Retrieved from <http://utahscience.oremjr.alpine.k12.ut.us/sciber00/7th/cells/sciber/orgtable.htm>

Swafford, A. L. (n.d.). Carolus Linnaeus: Classification, Taxonomy & Contributions to Biology - Video & Lesson Transcript. Retrieved from <http://study.com/academy/lesson/carolus-linnaeus-classification-taxonomy-contributions-to-biology.html>

Akuna, J., Bauwens, J., Bauwens, W., Ewen, S., Podlewski, S., Quigley, J., & Stodden, N. J. (2008). Science Dictionary: Dichotomous Key. Retrieved from <http://www.webquest.hawaii.edu/kaahihi/sciencedictionary/D/dichotomous.php>

Dawley, L. (n.d.). About 3D GameLab. Retrieved from <http://rezzly.com/about-2/>

Fig. 1. Author's screenshot. (2016, November). *E and Eve's Electrical Endeavors*. From *Serious Games in Education*. Stege, L., Van Lankveld, G., & Spronck, P., 2011, Tilburg, The Netherlands: Tidburg University.

Fig. 2. [Pixel Boy]. (2014, June 29). *Armour Crafting*. [Image File]. Retrieved from http://www.htxt.co.za/wp-content/uploads/2014/06/Armour_Crafting.jpg

Fig. 3. [Curse]. (2016, December 5). *QuestGuru*. [Image File]. Retrieved from <https://media-curse.cursecdn.com/attachments/130/799/b7ef9923828960d1a0935b08fb5ac0d2.jpg>

Fig. 4. [Pesto81]. (2014, January 7). *Ony Down*. [Image File]. Retrieved from <http://www.pesto81.com/images/wow/Ony%20Down.jpg>

Fig. 5. [Blizzard]. (2016, October 28). *Battleground Bonus Event*. [Image File]. Retrieved from http://bnetcmsus-a.akamaihd.net/cms/blog_header/7y/7YU4ZX6YB7PJ1437411097181.jpg

Fig. 6. Sheldon, L. (2012). *Valeria*. [Image File]. From *The multiplayer classroom: designing coursework as a game* (p. 159). Sheldon L., 2012, Boston, MA: Course Technology