International Journal *of* Designs for Learning
2021 | Volume 12, Issue 2 | Pages 40-48

CHOOSE YOUR OWN ADVENTURE: GAMIFIED COURSE DESIGN IN HISTORY OF SCIENCE

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To combat high dropout rates and low motivation for online courses, we gamified a history of science course. To do so, we used an online educational program called 3DGameLab to convert what had been a well-liked face-to-face lecture and discussion course to an online format, for the purposes of long-distance teaching and learning. Within 3DGameLab, we prepared approximately three times as much content as would be taught in a face-to-face class. Clear tasks and immediate rewards in the form of experience points (XP) contributed to a transparent motivational system as compared to traditional grading. In this course, students completed their assignments asynchronously. Sustaining engagement is challenging in this format due to student self-management, but, with the game mode, students could repeat their attempts to pass a quest (a lesson) until they succeed (submit a passable response). The feedback cycle was short, and we found that students tend to persevere in the face of failure when they get rapid feedback, rather than quit. To test the adaptability of the asynchronous, gamified format, we also designed this course as a hybrid course. Students remained engaged when the feedback was quick, and the tasks were clearly set. We did not perform a quantitative study; the purpose of this article is to share a design study of our methods and subsequent experience with these modalities.

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INTRODUCTION

In 2014, we redesigned a popular undergraduate history of science survey course from a face-to-face format into an online class. Rather than trying to capture or imitate the original lectures and discussions for the course, we sought to explore the affordances of an asynchronous online course. In addition to our initial move towards self-paced learning, we also worked to introduce the idea of student choice in content and even assignments. Ultimately, we arrived at a "choose-your-own adventure" format for the course.

By allowing students to pick their own content from a curated but diverse menu of options, we hoped that aspiring mathematicians, engineers, artists, and humanists would each find historical topics that informed their major studies and personal interests. Similarly, students were able to choose their own assignment submission style, and in doing this we aimed to hone their strengths. Although many students find comfort in the familiar structure of an argumentative essay, others might find the chance to present a Power Point deck, record a podcast, or produce a video more interesting or useful in their career preparation. If students are experimenting with the modalities of historical narrative through a variety of experiences, then we as history professors have done our jobs.

Prioritizing this goal of student choice required that we, as course designers, present enough information about the content and assignments in every quest in the course's menu of options. We needed to preview the historical stories and their importance in broader historiographical study. We

https://doi.org/10.14434/ijdl.v12i2.28949

also needed to guide the students through their choices in assignments while allowing them freedom in their historical interpretations. In this design study, we will detail how and why we designed this student-centered, online history course and what we have learned from teaching it in a variety of forms for the last six years.

DESIGN CONTEXT

At Missouri S&T, History of Science is a popular upper-level history course that presents, in one semester, a survey of the history of science from ancient times to the present day in a mixed lecture and discussion format. The course is required for secondary education majors, and it is a top choice for an upper-level humanities elective for many engineering majors, which number well over half the student body. It also fulfills an upper-level European history elective requirements for history majors and minors. Sheppard has been the main instructor for the course since 2011, offering at least one section for 25-30 students every semester. For many semesters, she offered two sections, for a total of 50-60 students. Even then, there is often a substantial waitlist and some students who need the course have not been able to get in. Sheppard does not have access to TAs, so keeping the course size low is important for grading purposes as well as for keeping students engaged.

Sheppard was to go on maternity leave for the Fall 2014 semester. No one else at S&T was qualified to teach the course at the time, so I agreed to teach the course. I am based out of the University of Oklahoma in Norman, which is over 400 miles from Rolla, so we decided to shift the class to an online format.

Sheppard spoke to her then-department chair who supported new initiatives in course instruction, and suggested she apply for an internal grant. We were awarded a generous grant by the Center for Academic and Faculty Excellence (CAFÉ) at Missouri S&T to redesign the course. Even though they had not yet had experience with gamification, the instructional designers at Missouri S&T were able to see a number of benefits to having the course available online, and in a format that would promote student success. CAFÉ have continued to support Sheppard's online instruction projects. As far as we know, there were no logistical or other barriers to the course, save the instructional design work we had to do.

Although Sheppard's maternity leave was the impetus for the course design, the design process itself allows us to diversify the formats for the course. Our original design was adapted for the needs of each semester or course session, which provides a natural test that confirms the malleability of gamified course design. Since 2014, the course has been taught in the following ways (see Table 1):

Asynch/ Summer	Async/Full Semester	Blended/ Summer
	Rezzly	Rezzly
Canvas		

TABLE 1. Course formats.

The most recent formats of the course have been in asynchronous summer courses on Canvas in the summers of 2019 and 2020, which have been particularly popular with Missouri S&T students who could not attend in-person summer courses. With the major changes most universities have undergone with COVID-19, Sheppard is modifying the Canvas course to accommodate online learning for the Fall of 2020.

We will first discuss the original gamified design itself, and then we will detail how and why we changed the format, the timeline, the software, and some of the content.

GAMIFIED COURSE DESIGN

History of Science, like many other historical fields, has traditionally been taught through in-person lecture and seminar formats. Further, while online courses have become more common in the last five to ten years, they often retain the format of an in-person course: content delivery by readings and video lectures; assessment by exams or papers. This traditional format can be difficult for students to engage with, especially when they are isolated online. The course that we designed was the first to introduce gamification into the online course design for history of science.

According to online education experts Joey Lee and Jessica Hammer (2011), the *gamification* of courses "attempts to harness the motivational power of games and apply it to real-world problems," such as the motivational and engagement problems encountered by online courses (p. 1). Lee and Hammer propose using game mechanics such as level completion badges, leader boards, and experience points in courses. As gamification in online education has developed in the last decade, studies have shown the efficacy of additional game mechanics including shortened feedback loops, social features, communication channels, progress bars, and replayability (Antonaci et al., 2019). These game components provide motivation for students to complete assignments by allowing for competition against themselves and others, as well as giving them "clear, actionable tasks and promises them immediate rewards instead of vague long-term benefits" (Lee & Hammer, 2011, p. 3). That is, they see their points, and achievement levels, go up immediately. They earn badges and experience points and get to move on to the next level quickly. By shortening the feedback loop, we hoped to positively reinforce engagement with the course, even in isolation. For the first iteration of this course,

students worked asynchronously, meaning that they could move at their own pace rather than waiting on the professor and their peers, as in a standard lecture format.

Known problems with asynchronicity primarily have to do with motivation (Kaneb Center, 2014; Center for Teaching, 2019). Although faculty teaching in-person courses or synchronous online courses can help motivate students through interpersonal interaction, asynchronous courses depend largely upon intrinsic motivation from students. That is to say, in asynchronous online courses, students who are not internally or intrinsically motivated run the highest risk of not performing the basic steps required of them in the semester because they have not tasked themselves to do so. In order to succeed in an online course, one must be somewhat of a self-starter and self-motivator; we felt that the incentives of a leaderboard and a video game-like atmosphere, would add extrinsic motivation encouraging students to sit down to do a number of quests (Villanova, 2019).

There are challenges to our proposed model, such as that of failure (Lee & Hammer, 2011). But, within the course game mode, students can continue to attempt to pass a quest (a lesson) until they succeed (submit a passable response). The feedback cycle is short, and Lee and Hammer have found that, in circumstances where they are given multiple chances to succeed, students tend to persevere in the face of failure rather than quit. Further, extrinsically motivated students tend not to simply wish to pass the course, but to be at the top of the leaderboard and beat all their fellow students. All of these aspects allow for different levels of learning and different styles of learning brought to the course by each student (Lee & Hammer, 2011).

Course Learning Objectives

The learning objectives for this course remain similar to an in-person, lecture-style course. The history of science survey course is tasked with teaching what science is, how it has changed, and how it fits into the historical narratives of society and culture. Because the course covers such a long period of time—the 7000 years since the earliest written records—it is necessarily a survey of the important ideas, people, institutions and developments throughout time.

This course focuses less on the identification and remembering of specific historical details but instead, as with the new Big History movement, more on the ability to sequence broad developments and compare similar events across different historical contexts (see Big History Project, 2019 and Christian, 2018). Students are taught to investigate primary and secondary historical texts and relate the described historical events to the broader relationships between science, politics, economics, culture, gender, and more. The objectives can be summarized as follows:

- outline key episodes in the history of science and in broader social, cultural, and political history.
- critically interpret primary and secondary sources.
- explain the competing influences that went into both disruptive changes in scientific theory and the normal progress of scientific practice.
- evaluate the study and performance of science based on historical shifts in gender dynamics, politics, religion, and more.
- compose your own views of what policies would be beneficial for both the expansion of scientific knowledge and the ethical and equitable application of that knowledge in the world.

Although there are common touchstones in the history of science such as the work of Galileo or Darwin, there is a superabundance of potential case studies to choose from. Instructors often choose their specific content for this type of course based on their own historical interests and research specialties. This usually results in a well-informed course, but the historical arguments may seem esoteric and unrelatable for undergraduate students. By shifting the choice of content from the instructor to the students, which we will detail later, we hoped to increase the relevance of the course and thus the engagement of the students.

In addition to being able to analyze and synthesize historical events, students must also develop their abilities to communicate their findings. Marshalling examples into a research paper is paradigmatic for the field, but instructors are increasingly questioning the importance of teaching this model in introductory surveys to students who are not likely to become professional historians. As long as students can demonstrate their understanding of history through arguments backed by convincing evidence, their choice of modality, be it poster, slide deck, website, or video, does not detract from the assessment and may prove more useful practice for their personal goals. Thus, our course sought to maintain the core learning objectives centered on historical analysis and argumentation while allowing for negotiation around the choice of case studies and media for assessments.

Quests and Student Choice

Lee Sheldon from Indiana University has gamified portions of his courses by turning homework into "quests" (2012). Although it is possible to set up a quest model in well-known Learning Management Systems (LMS) such as Blackboard and Canvas, we chose to use an LMS called 3DGamelab (now branded as Rezzly) for this class because quests are central to the platform's design. Each quest has prerequisites, so the completion of one or more quests can unlock another quest or set of quests. Each quest can also reward experience points (XP) and badges or be part of a set of quests that rewards experience points and/or badges. The

quests consisted of mini-assignments of reading a short text, visiting a website, watching a short YouTube video, or some combination of activities, and responding to a short question. Often, the quests were also mini-assessments, asking simply "Did you read/complete the quest?" Other times the questions required some critical thinking and a short, 3-5 sentence response, or a video/audio response.

Stansberry and Haselwood (2017) have written about integrating 3D Gamelab into their course, "Games and Simulation for Learning." They noted, "[b]eing asked to choose your own path is typical in a digital game, but it is not typical in the average masters-level course…. We needed to create enough quests so students would be empowered to choose their own path, but no matter which path they chose, we would be confident they had learned the content" (p. 33). In our class, we adopted a similar "choose-your-own-adventure" model.

In our prior in-person courses, we have both used the concepts of the macrocosmos and microcosmos to give scope and structure to our courses. We start our courses with a unit on the astrosciences (astronomy and astrology) before moving on to the earth sciences (physics, chemistry, biology, geology and more) and finally to medicine and the body. We thus move from the large scale to the small scale and from the physical to the biological sciences. Our gamified course borrows this structure to organize our quests into campaigns.

The first assignments for each campaign introduce students to the time period or subject matter that they will encounter throughout the campaign. Here we pose overarching questions that they should consider as they are moving through quest groups. For example, in the Astro-sciences campaign, students should be thinking about how humans have viewed the cosmos and our relationship to the cosmos differently over time. Where is our place in the cosmos? Where is the Earth? What is the cosmos made of and how do we know? Much as a band of heroes would complete a series of quests as part of a larger campaign to defeat the raging black dragon Khisanth in the ruins of Xak Tsaroth (as you well know), our students must build a foundation from their conquests over Platonic and Aristotelian cosmology before they can hope to understand the nuances of Islamic hay'a astronomy or the epistemological utility of hand drawings of nebulas in the 17th and 18th centuries.

Again, a normal survey course is limited by time and the instructor's preferences in what subject areas it can cover. Although we both build some time into our in-person syllabi to explore topics that interest the students, the subject matter is unavoidably limited. Part of the value that the Rezzly online platform adds then is that we can put up as much content as possible in and then allow each student to make their own choices as to what content to study. As students move through their campaigns, they have a number of options for assignments. In one quest about Mesopotamian views of the cosmos, students learn about the sexagesimal (base-60) number system used by ancient Mesopotamians. They also learn to use a base-60 calculator to do some simple math. The main point of this quest is to teach them that there is more than one way to look at the heavens, even mathematically. They find it challenging, but also refreshing to have a new kind of assignment.

In the Earth sciences campaign, one of the quests has to do with *being* a 17th century scientist. Students are tasked with reading Isaac Newton's letter to the *Philosophical Transactions of the Royal Society* from 1671. In it, he describes his *Experimentum Crucis*, or crucial experiment, demonstrating that white light is made up of different colors of light. Students must read the letter (with modernized spelling) and then pretend they are the Royal Society's then-curator of experiments, Robert Hooke. They must draw the diagram of the experiment, by hand, take a picture of their work, and upload it into the system. First, students must place themselves in the 17th century mind and read a brand-new way

Code	Chron/Topic	Astrosciences	Earth Sciences	Biological Sciences	Medicine/The Body	Social Sciences
010	Ancient	ANE Cosmology	Ancient Earth	Domestication of Animals	Ascleplius	Religion
020	The Greeks and Romans	Plato, Aristotle, Ptolemy	4 Elements/Qualities	Aristotle's Zoo	The Greek Body	What is Natural Philosophy
030	Non-Western Groups	Islamic Astronomy	Meso-American Natural Philosophy	Life in Meso-America	East vs West	Non-Western Ways of Thought
040	Islamic Period	Ptolemy in Arabic	Islamic Alchemy	Botany and Agriculture	Hospitals	The Quran and the 'ilm
050	Medival Europe	Copernicus	Medieval Physics	Herbals and Bestiaries	Medical Training in Medival Europe	Universities
060	Scientific Revolution	3 Men and a Theory	Mechanics	Exploration and New World Biology	Andreas Vesalius	Psychology
070	Early Modern Europe	Reactions to the New Cosmos	Alchemy and Chemistry	How do we pass life along?	Circulation of the Blood	Theories of Personality
080	18th/19th Centuries	Seeing the Heavens	Geology (Rocks and Religion)	Evolution of Evolution	Medical Treatment of Women	Anthropology
090	20th/21st Centuries	Einistein and Uncertainty	The Manhattan Project	DNA and Life	Disease and Antibiotics	Archaeology

FIGURE 1. The Chronological "Map."

	Astrosciences	Earth Sciences	Biological Sciences	Medicine/The Body	Social Sciences
Chron/Topic	A00: Campaign Overview	E00: Campaign Overview	B00: Campaign Overview	M00: Campaign Overview	S00: Campaign Overview
Ancient	ANE Cosmology	Ancient Earth	Domestication of Animals	Ascleplius	Religion
The Greeks and Romans	Plato, Aristotle, Ptolemy	4 Elements/Qualities	Aristotle's Zoo	The Greek Body	What is Natural Philosophy
Non-Western Groups	Islamic Astronomy	Meso-American Natural Philosophy	Life in Meso-America	East vs West	Non-Western Ways of Thought
Islamic Period	Ptolemy in Arabic	Islamic Alchemy	Botany and Agriculture	Hospitals	The Quran and the 'ilm
Medieval Europe	Copernicus	Medieval Physics	Herbals and Bestiaries	Medical Training in Medival Europe	Universities
Scientific Revolution	3 Men and a Theory	Mechanics	Exploration and New World Biology	Andreas Vesalius	Psychology
Early Modern Europe	Reactions to the New Cosmos	Alchemy and Chemistry	How do we pass life along?	Circulation of the Blood	Theories of Personality
18th/19th Centuries	Seeing the Heavens	Geology (Rocks and Religion)	Evolution of Evolution	Medical Treatment of Women	Anthropology
20th/21st Centuries	Einistein and Uncertainty	The Manhattan Project	DNA and Life	Disease and Antibiotics	Archaeology

FIGURE 2. The Topical "Map."

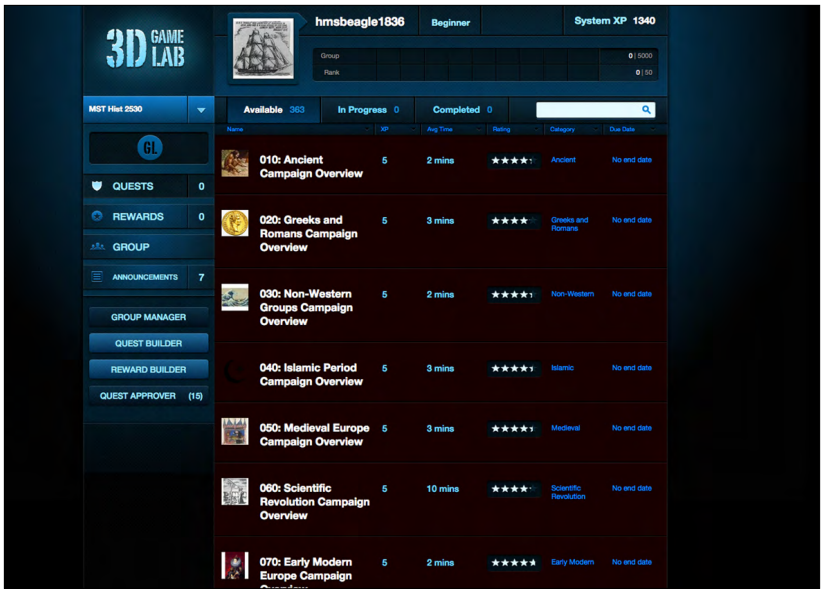

FIGURE 3. Example of the view of the 3DGamelab dashboard.

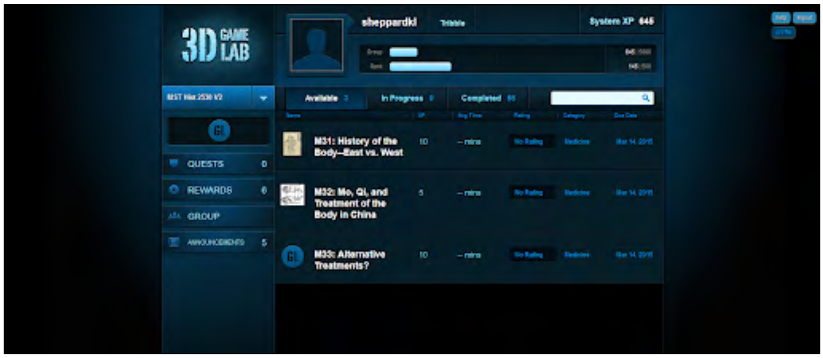

FIGURE 4. Quest group for the history of medicine in non-Western contexts.

FIGURE 5. Preview of a quest, at the start.

of viewing light, then they must use their hands physically to draw a diagram. Their diagram is not assessed for correctness, necessarily, but if they attempted to recreate the piece, demonstrating understanding.

In the Rezzly version of our course, there are ten available «campaigns", and to pass the course, students need to complete three. At the end of each campaign, or group of modules, there is a major deliverable, such as a blog post, a video short presentation, or a project so that the student is able to level-up. To help guide the students through this abundance of course material, we created a course "map" that showed different paths to completion. Students could follow chronological or topical paths through the course, depending on which campaigns they chose. They could also complete a combination of chronological and topical paths, depending on their interest area (see Figures 1 and 2). On each map, we also color coded the paths so they would be easier to follow.

If for example a student chose to do the Earth Sciences campaign, they would start with the "Ancient Earth" quests. Once they had completed the mini-assignments in those quests, the next set of quests, "4 Elements/Qualities," would appear in their 3DGameLab dashboard (see Figure 3, for example). We chose to limit the number of quests available at any given time rather than exposing the complete library of over one hundred fifty quests to reduce the cognitive load on students and to create linear paths through the material that would have more topical coherence.

3DGameLab also provides a preview text field where we can describe each quest (see Figures 4 and 5). We used these previews to tell the students what would be expected for each quest, the broader topical sets of quests, and the campaigns. Rather than asking students to make decisions based solely on the quest titles, we built in this signposting to inform their choices. Much like Stansberry and Haselwood explain, for this course, we kept "choice as an option [because it] meant students did not have to master each quest" (2017, p. 36). Further, it kept students from feeling overwhelmed by choices in the course (p. 32).

As students moved through campaigns and earned XP, their identity also changed. For example, completing the campaign about the history of medicine and the body, students earned the badge for Dr. Quinn, Medicine Woman. Simply earning XP would get level them up by earning achievements such as the lowest level of Skill Wraith, through higher-level identities such as Jar Jar Binks (Star Wars), and ending with the highest points achievement: Time Lord (Dr. Who).

There were two significant challenges in designing and building this course which required a significant shift from our prior courses: evaluating the affordances and limitations of LMSs and designing the choice-based course. Additionally, we had to collect and organize more course material than would be presented in a standard undergraduate course (or even most graduate courses for that matter). This challenge of volume did require extra work, but our collaborative development of the course made this manageable. Each of us had taught this course several times, so we were able to compile much of what was needed from prior teaching notes. We did create entirely new modules and contextualizations for the course content, but this happens to some extent for every iteration of a course. This challenge of scale served for us as an opportunity to discover how our individual experiences were complementary. We were able to collaborate and improve our abilities to teach the course moving forward. Both in co-learning a new delivery system and in co-developing new content, we benefitted from the collaborative opportunity.

RESULTS OF COURSE DESIGN

When we were initially designing and building the course, 3DGamelab was unique in that it allowed us to set triggers for the release of quests to individual students based on their unique paths through the course. Over the next few years, other LMSs including Blackboard and Canvas added increased functionality to their own course modules that allowed for similar, choice-based content delivery for students. Both Canvas and Blackboard had more robust discussion forums and grading tools, and students were more familiar with using those systems. Further, Canvas and Blackboard allowed us to set prerequisites for particular assignments, allowing us to help guide students through a particular path. Thus, our evaluation of which LMS would provide the best affordances and least limitations shifted from Rezzly back towards the standard LMSs used at our universities. Because of the malleability of gamification, shifting between LMSs was not particularly difficult. Sheppard put the content into Canvas, and Stewart helped to configure the settings for the modular layout and choice-based functionality.

There are challenges with some of these assignments, having to do with particular programs. With Rezzly there were issues with being able to assess efficiently and assign points quickly. Within Rezzly, the navigation between student submissions was burdensome slowing grading and increasing instructor frustration. We also had issues with getting content *out* of the Rezzly program once it was put in. There were some issues with cost, in that we had to maintain a license with Rezzly in order to access our information. Further, students had a few issues with registering themselves for the class, and some students thought that the program was too slow.

The gamified course has been taught at S&T four times, twice as online asynchronous, twice as blended. It has been taught at Oklahoma three times, all in the online, asynchronous, Rezzly format. Sheppard has been the only one at S&T teaching it, and at Oklahoma there have been two instructors. At S&T, three of the iterations used Rezzly, and two asynchronous iterations use Canvas (see Table 1). The shift was made because of the logistical issues with Rezzly that we previously discussed.

To solve the issues of content, we had the CAFÉ office at S&T help us move the content out of Rezzly, and into a series of documents. We can now pull that content out of each document and put it into any program we choose. Using Canvas, Sheppard was able to organize the online content into a short, 4-week Summer session course. Stewart helped with the organization and logistics within Canvas. Each week is a different topic, organized in terms of macro- to micro-cosmos: the cosmos, the planet, the body, and technology. Students are still able to choose their specific quests and modules based on their own interests, but the content is easier to navigate in Canvas.

We have found that, in whatever system we choose to use for any given iteration, we have built a user-friendly and moveable course over multiple campuses and through many semesters. Content is easy to add or hide, and we are able to give students the most up-to-date material in this way. For example, for the Summer 2019 section, Sheppard updated a number of quests to include new research about women's participation in a number of fields.

Online version of the course

The online-only version of the course had a broader range of subject matter, and simply *more* of it. As we said previously, we wanted to give students options. They were basically designing their own course with some guidance from the coding, so we were able to add a lot of material neither of us have time for in face-to-face or blended courses. Students tended to appreciate the fact that they could choose their own adventure through the course, based on their interests. A few remarked that choice stresses them out, but only because they are disappointed to miss some material.

Many students began the course thinking they would like the freedom asynchronicity offered, but in the end, many found that they had a difficult time setting their own deadlines (Villanova, 2019). Students, in general, liked working at their own pace, but found it difficult to stay on task when other classes with fixed deadlines took over. To help fix this, Sheppard added more deadlines in the latest versions (Summer 2019, 2020) of the asynchronous course. Students were allowed to work at their own pace through each distinct unit, which comprised a week, but in a limited fashion. The course was asynchronous in that participants did not meet online at a particular time. However, all assignments

were due each Friday by midnight. This was both to motivate the students to keep up with the content, as well as for the management of the instructor's grading schedule.

Blended version of the course

Sheppard taught history of science at S&T using a blended format using some Gamelab components and face-to-face lecturing, in two separate iterations: the 2015 Summer session and the Fall 2016 semester. The Summer session consisted of meeting for class five days per week during the month of July, for two hours per day. The first hour was for traditional lecture, the second hour consisted of students completing quests on their own. The rate of completion was equivalent to attendance.

During the Fall 2016 semester, it worked slightly differently. Mondays and Wednesdays were for traditional lecture, and Fridays were for the completion of Gamelab quests, outside of class. Despite the fact that students were consistently reminded to do their quests, due Fridays, some did not complete them. Students who remembered or chose to complete the quests did well in the course, overall, given that the quests made up 30% of their grade. This blended situation demonstrates some support for the gamified system needing extrinsic motivation, that is, physically being present to do the work.

An overwhelming majority of students liked the blended format. They liked the fact that the online portions were a change of pace from the standard format of lectures and reading. Those who completed the quests were therefore able to complete a significant portion of the course requirements on their own time. Further, many students remarked that the online portion of the course allowed for choice in what they were learning, which was one of the goals of the class format. Many of them commented that the blended format helped them to set deadlines for themselves, whereas in the online asynchronous format, they had a hard time managing the deadlines.

Face-to-face version of the course

It is difficult to teach a gamified course in person, especially when you depend on the online format to allow both students and the instructors some latitude. However, there are certain lessons that Stewart and Sheppard have implemented from the online-only and blended versions of the course into their standard in-person courses.

Sheppard has begun using more video and audio resources in her in-class lectures in all of the courses she teaches. She also has implemented more concentrated discussion sections, where, even in a class of 25 students, she can treat it more like a seminar class. Students do a short reading or watch a short video, then get into groups to answer questions with a 2-3 sentence response before discussing them with the rest of the class. Finally, she has implemented a permanent change in format for her 50-minute long courses that are scheduled on Mondays, Wednesdays, and Fridays. Mondays and Wednesdays are usually for lecture, the purpose of which is to impart information to students. These set up the context for more involved activities every Friday. These activities may be presentations, discussions, or using analog or digital tools in class. She attempts to reach all learners by changing the type of engagement.

FIGURE 6. The start of the week, in Canvas.

Short format versus the full semester

Because we ran the first iteration of the course in 2014, there have been a number of other times we used the gamified system in Rezzly (3DGamelab), both for online full semesters and blended full semesters, as explained previously. Sheppard used Rezzly in a summer course format that was blended, also explained previously.

The most recent short iteration of this course was at S&T for the June session of the summer in 2020. Sheppard found that because the number of students needing the class was so high, and most students were on internships or co-ops in the summer, an online class would be useful. The course cap was 20 students, and a total of 28 enrolled. By the end, 7 had dropped due to lack of time in a full-time work schedule. Using much of the material from Rezzly, Sheppard updated lessons and uploaded everything into Canvas, the current LMS at S&T. Sheppard organized the class into 4 weeks of material, with each week being a different topic in the history of science: how humans view the cosmos, how humans view the planet, how humans view the body, and how humans use technology. At the start of each week, students completed a set of text readings and took a reading quiz over the week's topic (see Figure 6)

However, they still had a choice of assignments. After the text reading and quiz, students were given 9 modules from which they had to choose 6 in order to complete the week's requirements. At the end of the week, they organized and created a VoiceThread to respond to one of three weekly reflective questions. Although this particular iteration is not gamified, students were kept engaged by a few tactics. First, although the course is technically asynchronous, there were deadlines each Friday at midnight for that week's assignments to be completed. This deadline kept them working on a relatively organized and not too constricted schedule. Second, the assignments were set up as modules, much like the Rezzly format, so students could move through them in discrete and manageable chunks of information and topics (see Figure 7). Finally, the assignments within each module are technically mini-assignments so that students must read, think, and absorb the material without having the requirement of a product every time. These are presented as multiple-choice quizzes that self-grade. There were larger assignments, such as watching a long video and responding with a few sentences to 1-2 paragraph assessments as well, so they are critically thinking and writing in smaller, more manageable chunks. These, more than traditional assignments, tend to keep students engaged online.

With the summer 2019 and 2020 versions of the course working so well in Canvas, Sheppard is also able to follow student progress in real time and answer any questions or deal with any problems right away. The students and the instructor are therefore able to interact on a much more meaningful basis, even though they never saw each other in person. The shorter course seems to benefit the most from the gamified format. We plan to write another short article about the logistics of setting up this style of Canvas course, soon.

CONCLUSION

We gamified a traditional face-to-face history of science survey in order to give students choice in the content of the course and give students choice in the assessments for

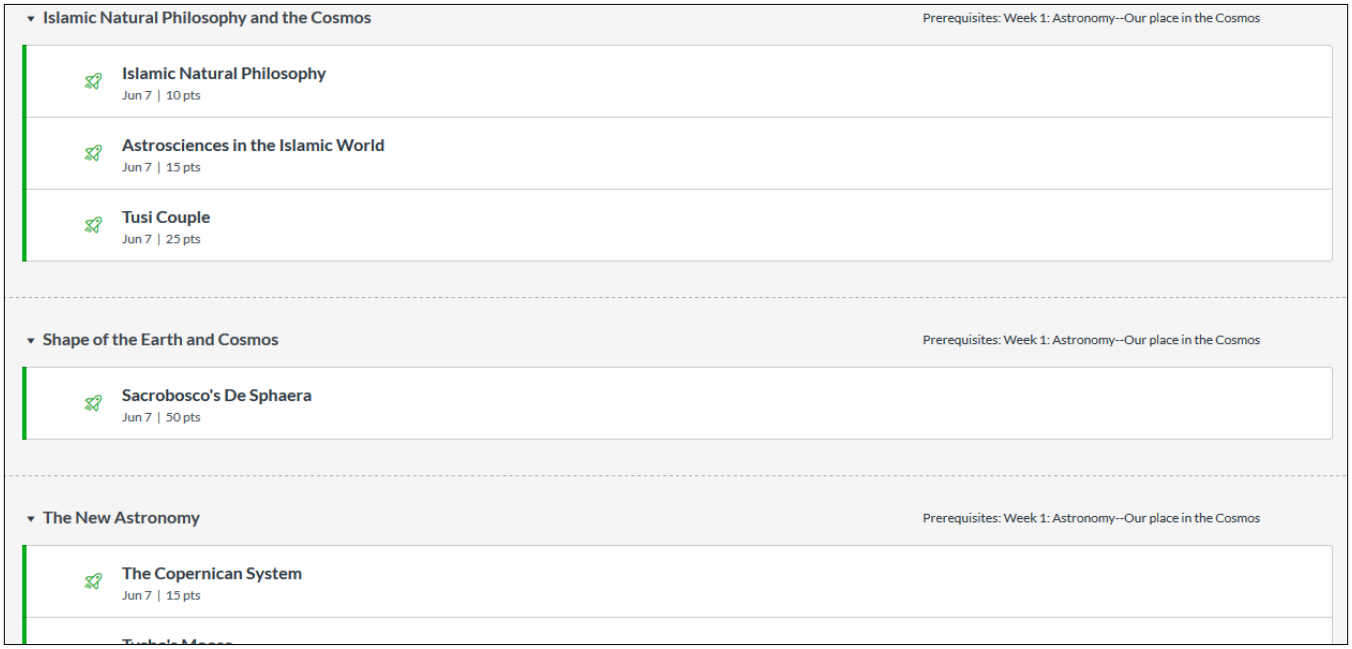

FIGURE 7. Modules in Canvas.

the course. We have iteratively designed multiple versions of the course working to make sure that students can navigate these choices, even with complex course content. Throughout the multiple iterations over different formats, our general conclusions, namely that gamification increases engagement and motivation, bear out in the course success rate.

Students were engaged in both the online and blended formats of the course, although they tend to engage better with the Canvas version of the course than the Rezzly course. We have found what others (Lee & Hammer, 2011; Sheldon et al., 2017) have found—gamification does increase student motivation, especially in asynchronous online classes. Gamification is an attempt to counter the high attrition rates of online, asynchronous courses. Our gamified online course was a step in the right direction in improving retention and engagement, but it still had a higher attrition rate than our traditional face-to-face courses.

Our initial gamified design was based on the increased space for student choice within our asynchronous course. Allowing students to choose their own path, while also earning XP, helped to keep our students engaged, even when they are isolated from other students. Although instructors sometimes rail against asynchronous online learning, especially during times when we have no choice but to be distanced from one another, we have engaged students in online courses and have seen them desire to complete the course assignments on time. We were also able to apply gamification to a number of blended and synchronous course formats. In our earlier courses, face-to-face discussions had generally focused on a common reading or activity. In the hybrid versions of this course, we found that student choice of course material enriched the discussions and provided an increased range of historical examples. We have learned from this experience how tools built for asynchronous courses can be repurposed back into our own hybrid and face-to-face courses.

In the future, quantitative studies of the effects of both individual and groups of gamification mechanics on motivation would be useful in better understanding the impact of gamification on student retention.

ACKNOWLEDGMENTS

Stewart and Sheppard would like to thank Missouri S&T for the generous funding to redesign this course, and to thank our students for being honest in their assessment of these new tools.

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